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POWER AND GAS

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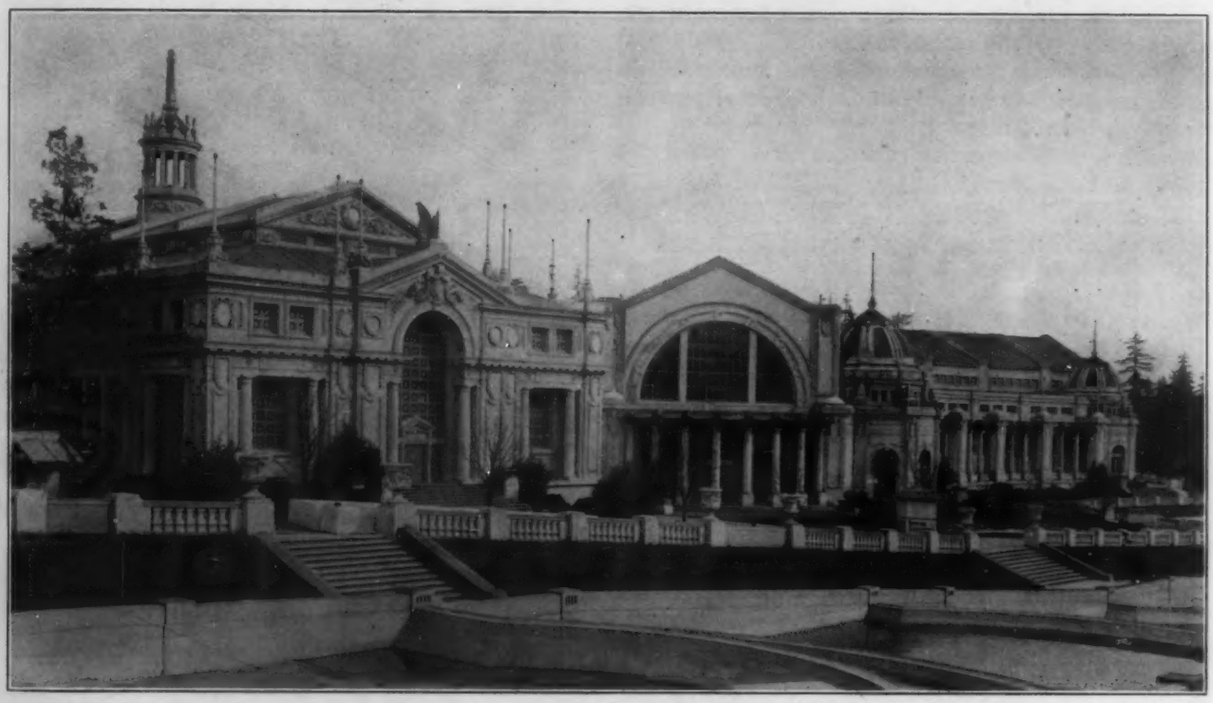
POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy.

VOLUME XXII. SAN FRANCISCO, APRIL 24, 1909. NUMBER 17

ELECTRICITY AT THE EXPOSITION

BY J. S. HARISBERGER



Portion of Grand Canal Showing Oriental Building and Manufacturers' Building, Alaska-Yukon-Pacific Exposition, with Cascades in Foreground.

THE Alaska-Yukon-Pacific Exposition to be held at Seattle from June 1st to October 16th, 1909, is representative of the natural and developed resources of the Alaskan and Yukon Territories and the Pacific Northwest.

It is said to have the most beautiful natural site of any exposition ever held. It will occupy about two hundred and fifty acres of the campus of the University of Washington, bordering on Lake Washington and Lake Union, two natural bodies of fresh water, having areas of thirty-eight and one-half square miles, and one and one-third square miles, respectively.

Looking over Lake Washington to the south, Mt. Rainier, is seen in its grandeur. Mt. Baker, another magnificent peak, is plainly visible from the grounds. To the northeast are the Selkirk Mountains, and to the west are the snow-covered crests of the Olympics.

The landscape artist has not allowed man to disturb nature any more than necessary. As far as possible the trees and shrubs have been left standing, resulting in many natural park effects.

In the development which characterizes a modern exposition, the supply of electricity for illuminating and power purposes becomes an important consideration. Seattle is particularly blessed in having an abundance of water power, a comparatively short distance from her doors. Her proximity to snow covered mountains enables her to take advantage of the result of Nature's ideal method of storing power.

Some of this power obtained from the glaciers of Mt. Rainier, in the Cascade Range, has been developed by the Puget Sound Power Company. This company furnishes power to the Seattle Electric Company, who have been granted the exclusive right to furnish all electric current used on the grounds. They also furnish all power for electric cars carrying passengers to and from the Exposition.

The hydro-electric plant is located at Electron, fifty miles away, from where power is transmitted to Seattle at 55,000 volts, 3 phase, 60 cycles. At the main Seattle substation this current is transformed down to 13,800 volts, 3 phase, at which pressure it is transmitted to the substation at the Fair grounds, a distance of about five miles.

The substation, or service plant, is located on the west border of the Fair grounds, about half way between Lake Union and the northern boundary. It is a wooden frame structure of pleasing design. The plant has been laid out on the simplest lines possible to reduce complication and to insure reliability and ease of operation. Standard apparatus has been employed as far as possible, and of such size units as can be used elsewhere after the fair.

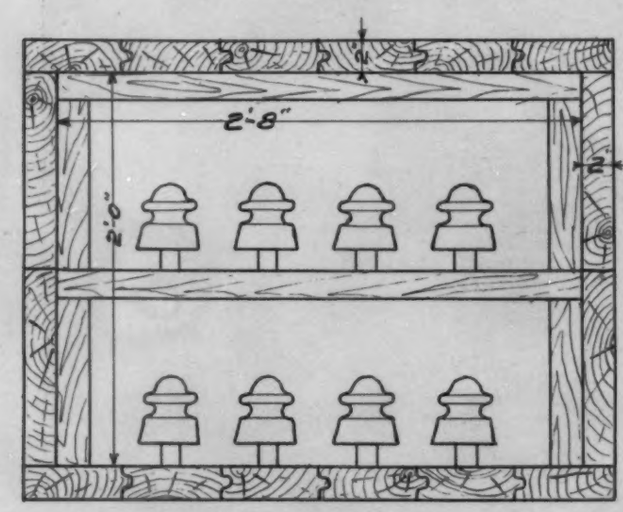


Fig. 1. Underground Conduit, A. Y. P. Exposition.

In this plant are four 1,000 k.w. G. E. air blast transformers connected in two banks 3 phase-2 phase, 13,800 primary, 3 phase side and 2,300 volt secondary, 2 phase side. These transformers are kept cool by two Buffalo Forge Company's blowers, direct connected to two G. E. 4 h. p., 220 volt 2 phase induction motors, 720 r. p. m.

In this station are also two G. E. synchronous motor generator sets for furnishing D. C. power to the street railway in the vicinity of the Exposition; these sets may be started from either A. C. or D. C. side. Each of these sets consists of one rotary field 1,400 h. p., 13,800 volts 3 phase synchronous motor 514 r. p. m., one 1,000 k.w., D. C. class 10,600 volt generator having commutating poles, exciter being mounted on same shaft. These sets are controlled from switchboards of standard design. The 13,800 volt switches are of the oil type, electrically operated, remote control, with overload release.

On switchboards are also mounted two Tirrell regulators for varying the power factor so as to maintain good voltage regulation on the A. C. feeders. All wiring in station is rubber insulated with flame proof covering. Circuits of 2,300 volts and over are controlled by oil switches with overload release. From this station all feeders leave overhead and are strung around the edge of the grounds on a pole line, from which connections are made at eight different points to circuits in underground wooden ducts, as shown in Fig. 1. These ducts are buried to a depth of about three feet and carry the 2,300 volt circuits to the transformer vaults installed in the larger buildings. There are four single phase 2,300 volt feeders for twenty-four hour service; three two phase 2,300 volt feeders for decorative lighting, and one two phase 2,300 volt power feeder; to this feeder are connected all services for power purposes including three 200 h. p. Westinghouse induction motors direct connected to four stage

Fig. 2. Electroliers.

Worthington pumps to be used for pumping water from Lake Washington for fire protection, etc.

On feeders for the twenty-four hour service are the usual indicating meters as well as Bristol recording volt meters, and in each circuit is an induction regulator.

The current supplied to feeders for decorative lighting is controlled by a water rheostat which brings the lights gradually up to candle power, an arrangement similar to that used at the Pan-American Exposition.

The transformer vaults are located next to the outside walls of the buildings with direct outside access, and are so constructed that they are practically fireproof, having ample ventilation to carry off all heat from the transformers. The walls and ceilings of the vaults are built of two thicknesses of two-inch plank laid in opposite directions, with an interlining of asbestos board laid between the two thicknesses

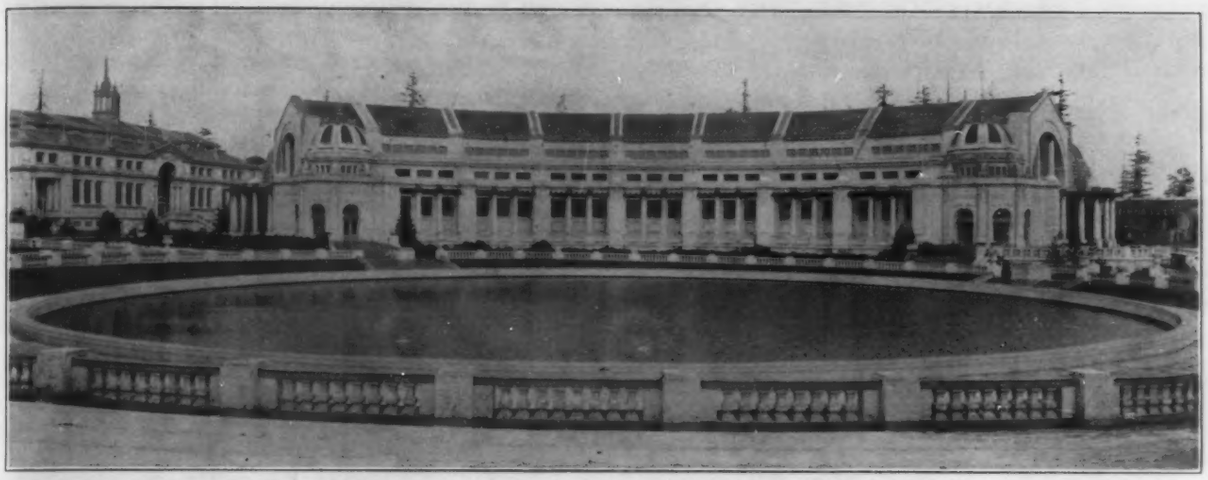
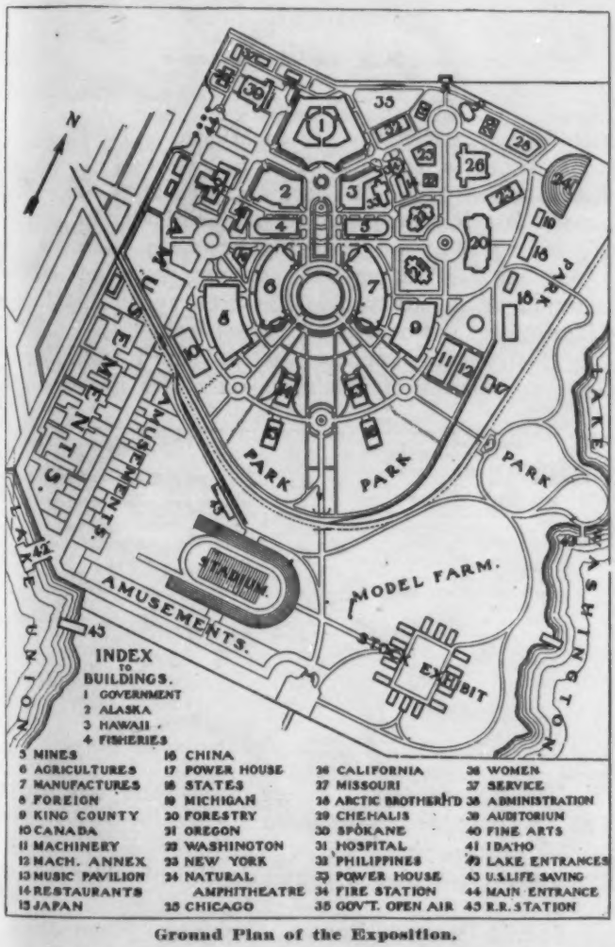


Fig. 3. Looking Across Geyser Basin Toward Manufacturers' Building.

of plank. The inside of all vaults is lined with galvanized iron.

In these vaults are installed oil insulated, self cooled transformers for stepping down the current from 2,300 volts to 117-234 volts for three wire distribution.



Ground Plan of the Exposition.

In the Government Building is installed a 100 k. w. motor-generator set for furnishing 230 volt direct current for three wire distribution, this being necessary for the Government exhibits; with this exception, all current on the grounds is alternating.

Wiring in the permanent buildings that will revert to the University of Washington after the Fair, is first class conduit work. In all other buildings wiring is exposed, using flame proof wire.

Incandescent lamps are used throughout, excepting a few other types which may be used for exhibition purposes. For decorative lighting, frosted eight candle power lamps will be used entirely, placed eighteen inches apart on outside of buildings in such a way that indirect illumination will be effected, bringing out the outlines of the buildings and such parts of the buildings that architectural features may suggest.

For the art gallery 100 watt tungsten lamps with shovel reflectors will be employed. Around the grounds will be used about two hundred and fifty electroliers as shown in Fig. 2. This design was specially gotten up for the Exposition. The globe on it contains thirty-nine 20 candle power frosted lamps.

The Geyser Basin, Fig. 3, is one of the features of the Exposition. The bottom is studded with incandescent lamps which give a very pretty effect at night.

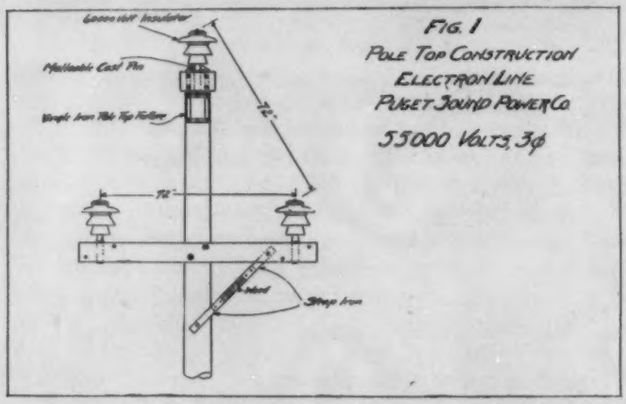
The Cascades is a series of six waterfalls over which tumble ten thousand gallons of water per minute. Behind each fall is a line of light which gives a beautiful rainbow effect through the water. The water supplying the Cascades is circulated by two Krogh pumps, one belted to a 50 h. p., and the other to 100 h. p. Allis-Chalmers induction motor. These pumps are installed in the Agricultural Building.

Cactus sap as a rubber substitute has been the subject of successful experiments by a forest officer in India. The cactus or plant from which the sap was taken for these experiments is described in Watt's Dictionary of Economic Products of India as a "large, fleshy shrub common on rocky sides of the outer Himalayas from Koumourin, and at an altitude of 6,000 feet. The milky sap of this plant contains a large amount of gutta-percha." Should the sap of the American cacti prove available for the purpose described, it would open up a new and valuable industry. The U. S. Consul General at Calcutta will be glad to connect anyone with the Indian officer in question.

NOTES ON TRANSMISSION PRACTICE IN THE NORTHWEST[1]

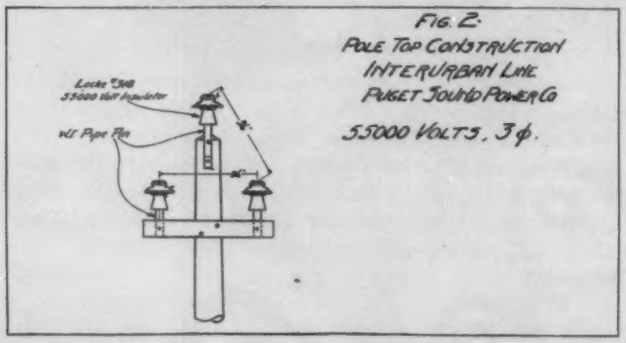
BY MANGUS T. CRAWFORD.

The object of this paper is to assemble in a form convenient for comparison and discussion the various systems of high tension transmission in the Northwest, and to discuss the relative merits and defects of each system. As each section of the country has its own characteristic set of climatic and industrial conditions, transmission practice features that are economical and good practice in one section may be more or less unsuitable in another section. For this reason this discussion will be confined to practice in the Pacific Northwest. As typical examples, a number



of systems will first be briefly described, and discussed in detail later.

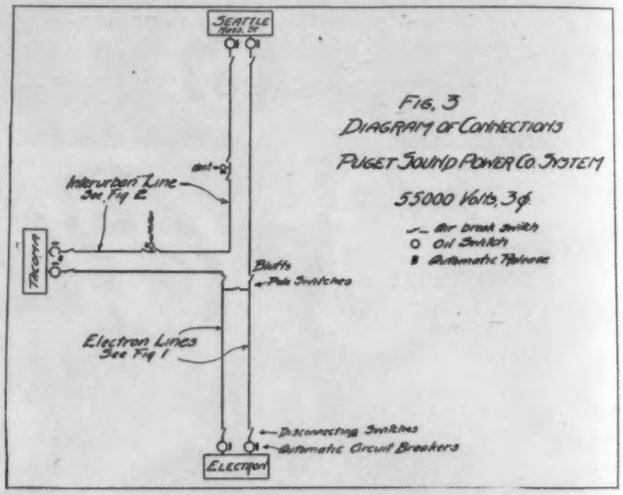
Puget Sound Power Company. This company operates a hydroelectric station at Electron, Washington, on the Puyallup River. Two 55,000 volt, three phase lines run parallel to Bluffs, where they separate; one goes to Tacoma, the other to Seattle, following the Puget Sound electric railway right of way. These lines were built in 1903 and have the construction shown in Fig. 1. The wire is OOOO B. & S. 19-strand



semi-hard-drawn copper, except from Bluffs to Tacoma, where it is O B.& S. solid copper. The insulators are standard four-piece, 60,000 volt porcelain on galvanized malleable cast iron pins of a design similar to a pipe pin. Part of this line was equipped with wooden pins for trial, but the iron pins have proved more satisfactory. The length of the Seattle line is about fifty miles, that of the Tacoma line about thirty miles. At the generating and substation each line is controlled by a switchboard panel equipped with three ammeters,

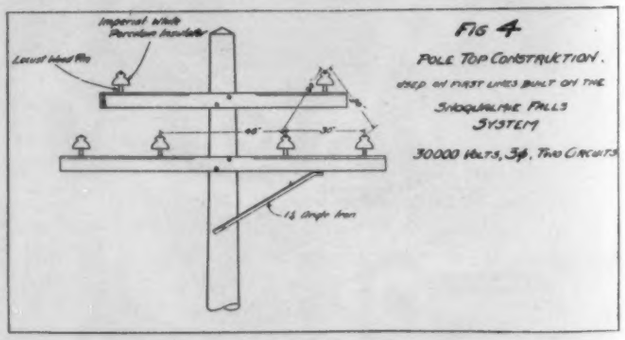
[1]Paper read before Seattle Section of the American Institute of Electrical Engineers, December 19, 1908.

one automatic, remote control, oil circuit breaker, and one overload time limit relay. The circuit breakers are electrically operated oil switches in concrete compartments. At Bluffs, disconnecting pole switches are used for paralleling and cross connecting the lines, as shown in Fig. 3. A second line of solid copper, known as the interurban line runs parallel and on the opposite side of the railway, feeding into substations located at Massachusetts street, Seattle, and at Kent, Milton, and Tacoma. The size of the wire is 1 B. & S. solid copper from Seattle to Georgetown,



4 B. & S. from Georgetown to Milton, and 1 B. & S. from Milton to Tacoma. This line is constructed as shown in Fig. 2, and has been operated at 55,000 volts for the last few months. It was originally built for this voltage, but until recently has been operated at 30,000 volts. Although the spacing between wires is rather small, no trouble has been encountered, as the spans are not over one hundred feet.

This company reports practically no trouble from electrical failures of insulators on either line, as all



insulators were tested before they were accepted. The only trouble has been from softening and burning of wooden pins. These pins have been replaced by wrought iron pipe pins, and no difficulty has arisen since.

Seattle-Tacoma Power Company, Snoqualmie Falls System. The system of this company has been in operation for ten years, and is the oldest high tension transmission system on Puget Sound. Some of the apparatus installed is of a type now obsolete, but the plant is being gradually rebuilt, and much of it is new

and modern. The main generating station is at Snoqualmie Falls. As originally built, this system consisted of a double pole line from Snoqualmie Falls to Renton, and single pole lines from Renton to Tacoma and from Renton to Seattle. Each pole line carried two three-phase, three wire, 30,000 volt circuits arranged as shown in Fig. 4, with a space of thirty inches between the wires. The wires were of alluminum with a cross section of approximately 65,000 cir. mils. The insulators were triple petticoat imperial porcelain of the Redlands type. After a few years' operation, this system was rebuilt with larger wires and a larger space between them. Various difficulties were encountered with the thirty-inch spacing—large

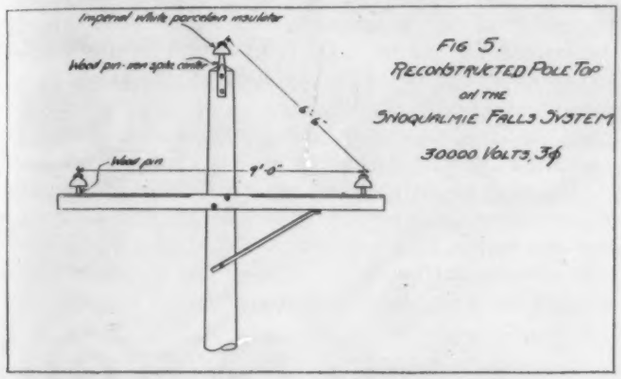


FIG 5.
RECONSTRUCTED POLE TOP
ON THE
SNOQUALMIE FALLS SYSTEM
30000 VOLTS, 3φ

birds, sticks, bale wire, etc., became entangled in the wires, causing short circuits. A wire once burned off was apt to whip around and short circuit the others as well.

In 1903, the lines were reconstructed with only one circuit per pole line, giving a nine-foot by six and one-half foot flat triangular spacing as shown in Fig. 5, by simply removing the top cross arm and putting on a pole top pin. A new pole line was built from Renton to Tacoma, and one from Renton to Seattle,

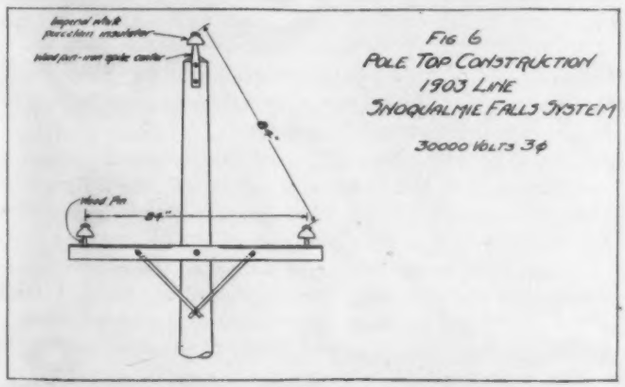


FIG 6
POLE TOP CONSTRUCTION
1903 LINE
SNOQUALMIE FALLS SYSTEM
30000 VOLTS 3φ

with a seven-foot triangular spacing as shown in Fig. 6. The same insulators were used, as they had proved satisfactory. This gave two separate pole lines from Renton to both Seattle and Tacoma. On these lines a seven-strand aluminum cable of OO B. & S. gauge was used, and from Renton to the falls each line was of seven-strand aluminum OOOO B. & S. gauge. The reconstructed system has now been in operation about five years, and the wide spacing has given almost entire freedom from trouble due to short circuits between the wires. As shown on the sketch, the insulator pins are of locust wood. About a year ago these pins began to give trouble from burning and softening. They were replaced on curves and important points by malleable cast iron pins.

In 1906, this company built a single pole line from Snoqualmie Falls to Everett, with the construction shown in Fig. 7. The line was of No. 4 medium hard drawn copper, and the insulator of shape similar to the imperial white insulator on the main lines, but made of brown porcelain. Malleable iron pins were used throughout, being fastened to a channel at the pole top as shown. The porcelain was not of so good a quality as that in the imperial white insulators, and occasional trouble resulted from insulators shooting through the

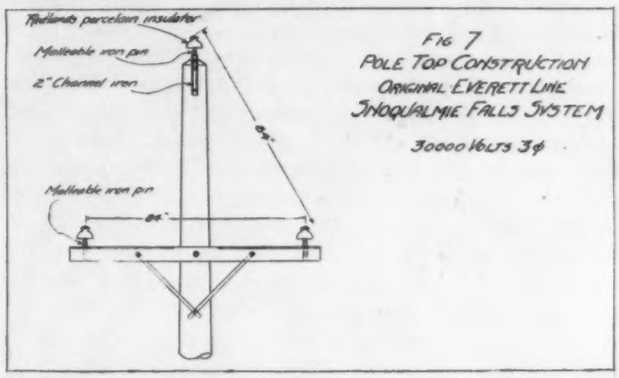


FIG 7
POLE TOP CONSTRUCTION
ORIGINAL EVERETT LINE
SNOQUALMIE FALLS SYSTEM
30000 VOLTS 3φ

head to the pin when a ground came on the system. In 1908, this line was reconstructed for 60,000 volts in order to carry the increased load, and as the first step in the change of the entire system to 60,000 volts. The new construction is shown in Fig. 8. There has been no trouble of any nature, though the line has been in service several months.

The general switching arrangement is shown in Fig. 9. There is no automatic release anywhere on main lines, as this company believes such apparatus

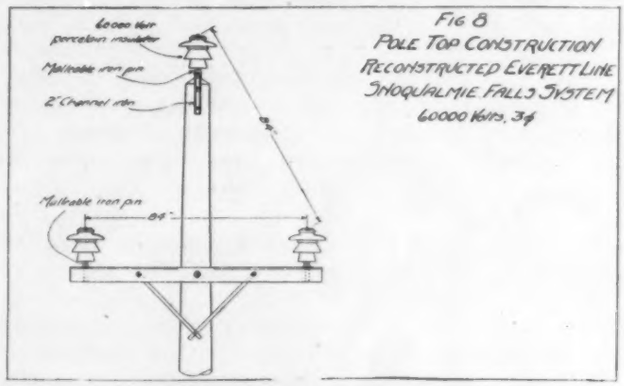
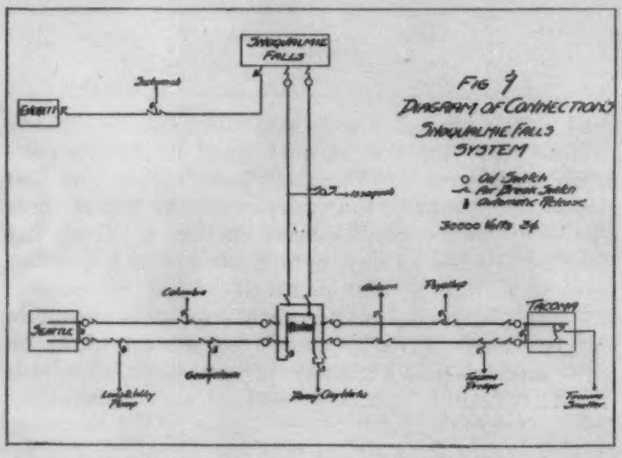


FIG 8
POLE TOP CONSTRUCTION
RECONSTRUCTED EVERETT LINE
SNOQUALMIE FALLS SYSTEM
60000 VOLTS, 3φ

to be a hindrance rather than a help. This will be discussed more fully later. The switches used at the falls are non-automatic oil switches in compartments. Those at Renton, Seattle, and Tacoma are tank switches, consisting of a double break switch immersed in a separate tank of oil for each leg of the line. They are controlled manually by an arrangement of levers. This company has never had any trouble from high tension oil switches, although they have been used to open some severe short circuits. On outside lines, a disconnecting pole switch is used. For branch lines, a horn fuse is also used, either on a

pole or on a bracket fixture on the outside of the station wall. Small substations are equipped with an air break fuse inside the station.

Seattle Municipal Power Plant. At present, this system consists of one 30,000 volt transmission line connecting the generating station on Cedar River with the substation in Seattle. This line is of the same construction as that is Fig. 6, except that a three petticoat, two piece, 45,000 volt insulator is used. The pins are of eucalyptus wood boiled in oil; the wire is No. 2 solid copper with a seven-foot spacing. This line was built in 1904, and has given virtually no trouble from electrical failures of insulators or burning of pins. It is controlled by air break disconnecting switches on the high tension side, an automatic release being on the 2,000 volt side of the transformers at the generating station. A new line now nearing completion has a construction shown in Fig. 10. The line wire is OOOO B. & S. seven-strand copper, and the operating voltage is to be 60,000 volts. Spans are from 400 to 450 feet on the straight way. This is a radical departure from the present lines on Puget Sound, but represents the most recent practice in transmission. The old line is to be changed to



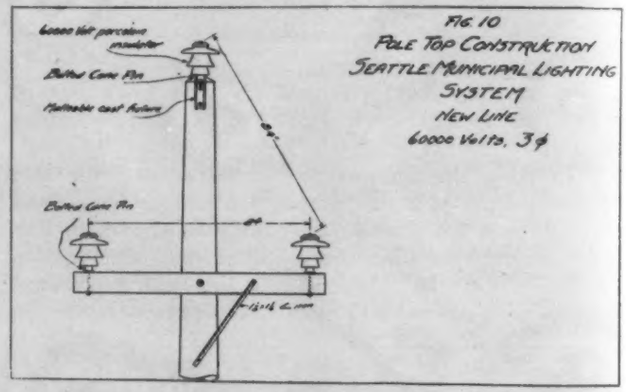
60,000 volts and the two lines will then be operated in multiple, with automatic oil switches on each line actuated by overload and reverse current relays.

Several months ago an attempt was made to operate the old line at 55,000 volts, the transformers being changed from delta to star connection. No difficulty was experienced in dry weather, but in wet weather so much trouble ensued that it was necessary to change back to the old voltage. The high voltage gave trouble by heavy leakage currents setting fire to the wooden pins. No trouble was experienced from electrical failure of the insulators during this time; there should have been no trouble, as the manufacturer's test on this type of insulator is 100,000 volts.

Whatcom County Railway and Light Company, Nooksack Falls System. This company has a hydroelectric generating station at Nooksack Falls, and supplies power to the city of Bellingham over a single transmission line. This line is built for 60,000 volts, but at present it is operated at 22,000 volts from delta connected transformers. The length of line is forty miles; the wire is O B. & S. seven-strand aluminum; the spans are about one hundred and fifty feet on the straight-away portion, while those at river crossings are as long as seven hundred and fifty feet. The pole top construction is shown in Fig. 1, except that a pipe pin is used, doing away with the pole top fixture. From the substation in Bellingham a branch line extends about two miles to Fairhaven, where there is a second substation supplying light and power to that section of the city. This branch line is connected to the main line by pole disconnecting switches. It is of the same construction as the main line with the exception of the spacing between wires, which is five feet, instead of six feet.

The only high tension switch used on this system is a simple knife disconnecting switch. All switching under load is done on the 2,000 volt side of the station transformers. Line short circuits open the automatic circuit breakers on the 2,000 volt side at the generating station, so that to obtain uninterrupted service it would be necessary to keep the steam generating station in Bellingham on the system at all times. This station is used only in emergency at present, as very little line trouble is experienced.

Having given some of the characteristic features of representative systems in this locality, a comparative discussion may now be of value. In this I shall draw freely on the experiences of the different companies, the opinions of their engineers, and also on



the opinions of representative engineers of the present day as set forth in recent papers before the American Institute of Electrical Engineers.

One of the things for which Western practice is criticized is the tendency to build lines that are cheap. Mr. F. G. Baum has said in a paper before the Institute:

> **It may not be as difficult to determine the proper power station and line to build when unlimited capital and ideal power conditions exist as when there is restricted capital, limited revenue, and low-priced power at the consumer's end.**

Mr. Baum's idea is the answer to such criticism. In the Northwest especially, the lines are very long, passing through rough country; the cost of the transmission system is a big item in the total cost; the power business is usually more or less scattered; and revenue comparatively small. Economy must therefore be given consideration by the engineer or his designs will not be feasible, and his enterprise will not receive financial support. It requires much more thought and engineering ability to design a satisfactory line with limited expenditure than it does where the line forms a small part of the total investment and its first cost is comparatively unimportant.

In consideration of these facts, the item of first cost will be given attention in the following discussion.

Line Wire. Opinion seems divided between aluminum and copper for use in transmission and high voltages, but in general it may be said that both are satisfactory. As examples for comparison, take OOOO stranded aluminum and OO hard drawn solid copper. The stresses at elastic limit are taken at 15,000 and 20,000 pounds per square inch for copper and aluminum.

	OOOO aluminum.	OO copper.
Resistance, ohms per 1000 ft	0.079	0.0787
Elastic limit, pounds tension	2500	2090
Weight, pounds per 1000 ft	195	403
Relative cost	90	100
Diameter over all, in inches	0.53	0.3648

There are many practical drawbacks to the use of aluminum; it is difficult to make good joints, as the metal will not take solder; it is a highly electropositive metal, and when exposed to the air in contact with other metals an electrolytic action is set up in which the moisture of the air and chemical impurities forms the electrolyte. These difficulties may be overcome by carefully made and protected joints. Aluminum has a very high coefficient of expansion with change of temperature, which is apt to be troublesome in climates having extremes of temperature. Its large diameter makes a larger surface for collection of sleet and ice and a larger resisting surface for high winds. In the Puget Sound country extreme temperatures, sleet, and very high winds are never encountered, so that aluminum is well adapted to local conditions. The systems using it have never had any difficulty which could be charged against the metal. As seen from the above figures, it is somewhat stronger, weighs about half as much, and costs ten per cent less for copper wires of the same conductivity. Ten per cent in the line wire is a fair size item in the line cost, and additional saving can be effected in freight and teaming in the delivery and stringing up in a rough country.

Poles and construction features. The question of poles versus towers is not considered in this part of the country, where excellent poles are obtainable on the ground and steel is expensive, although it may come in for consideration in later years. When the first lines were built in the Northwest, about ten years ago, the use of thirty-five-foot poles with seven-inch or eight-inch tops was considered good practice, as the spans were from one hundred and ten to one hundred and twenty-five feet, and the wires light. Much heavier wires and insulators are now used and the spans are longer, so that the tendency is to increase the size of the poles. The new line now under construction by the municipal light and power plant in Seattle is using fifty-five-foot poles with eleven-inch tops, on spans of four hundred and forty feet. On the Nooksack Falls line, forty-five-foot poles with nine-inch tops, on spans of one hundred and fifty or two hundred feet are used, which is about the same as on the 1904 lines of the Seattle-Tacoma Power Company and the city plant. It is thus apparent that the trend is toward longer spans, with fewer and more substantial supports.

The construction details of the pole top vary considerably in the different systems. In some installations in Utah and Montana the pole top pin is driven into a hole bored into the top of the pole. In the wet climate of the Northwest this construction would be apt to cause rotting of the core of the pole at the top, so that the pole top is always pointed to shed the water and the pin fastened to the side of the pole. The experience on every system using wood pins has been that after a number of years the pins are apt to soften or burn. The leakage of currents over the insulator to the pin forms nitric acid from the nitrogen in the air and the hydrogen and oxygen in the moisture, and the acid eats into the pin until the latter becomes quite pulpy. Wooden pins are usually carefully dried and boiled in paraffin or linseed oil, but even then they will begin to soften and burn in from five to ten years, depending on the line voltage. The Seattle municipal plant had a great deal of trouble a few months ago from charring and burning of wooden pins at the point of contact with the insulators, during the time that they were running 55,000 volts on their 45,000 volt line. In this case the leakage currents were so heavy that a high temperature was produced at the threads of the pin, due to the ohmic resistance to the passage of the current at this point. At the lower part of the pin and on the cross arm there was not so much burning, due probably to the accumulation of dirt and organic matter, and to the fact that the large wet surface offered a lower resistance.

Iron pins give entire freedom from such troubles, and also provide the strength necessary for long spans and heavy wires. There are several types of iron pins now in use. The simplest is what is known as the pipe pin, consisting usually of a short length of two-inch extra heavy wrought iron pipe swaged down at one end and cemented in the insulator. Another type consists of a cast iron cone with a steel bolt up through the center and screwing into a nipple which is cemented in the insulator. This type is used on the new city line. A third type consists of one solid malleable iron casting with tapering cross ribs above the cross arm and a round pipe shank or a bolt extending through the cross arm. This is held down by a through bolt or a bolt underneath the cross arm, and may be threaded and screwed into the insulator. The Northern Colorado Power Company has a pin of this type held down by a U-bolt extending around the outside of the arm. These are the three general types of iron pins now in use in the Northwest. The pipe pin costs from fifty-five to sixty cents, the bolted cone pin about fifty cents, and the malleable cast iron pin from twenty to forty cents, depending on the design. The pipe pin has the great advantage of simplicity and absence of bolted parts, and requires no pole top fixture; but, on the other hand, it requires at least a two and one-half inch hole in the cross arm, which necessitates a larger arm. As the insulator must be cemented on the pin, it is necessary to change the pin as well whenever an insulator is broken. With the bolted cone pin only a five-eighths inch hole in the cross arm is necessary, and as only the small nipple is cemented in the insulator it is not necessary to change the pin when

renewing an insulator. Some sort of casting or fixture is necessary at the pole top in order to use this type of pin, and the cost of this brings the cost up as high as the pipe pin. The malleable cast iron pin is simply of one piece, and with a threaded head it need not be changed in renewing insulators. If properly designed, it is as strong as the other types and is very much cheaper. By a little change in design it may be bolted directly to the pole top. In general, the practice is to design the pin so that it will bend over before the elastic limit of the wire is reached, so that, in case of an unbalanced strain in the line, the pin will bend and prevent elongation of the wire. The extreme rigidness of the bolted cone pin may, in such a case, prove to be a disadvantage.

Cross arms are invariably of straight, well seasoned fir, and should be painted or given a coat of preservative. Their cross section varies from four by six inches in short spans to six by eight inches with long spans and heavy wires.

The insulators used are usually of a standard type and made of porcelain. The city line has a few glass insulators, but while these are electrically satisfactory they are very easily broken and are rarely used. Experience proves that it is advisable to test all high voltage insulators before accepting them, especially for line work for over 30,000 volts. The cost of this test should not exceed five cents per insulator. The test voltage should be made at least double the line voltage. The insulators are set head down in a trough of water deep enough to cover the wire groove, and sufficient water poured in the pin hole to cover the threads. A metal rod is then put into the pin holes and the test voltage applied between this rod and the water in the trough. Where the insulator is made of several shells cemented together, each shell should be tested separately for its share of the voltage. It is of extreme importance that the porcelain in high tension insulators be of good quality and free from cracks or pits. On the Snoqualmie system, two different insulators of almost exactly the same shape are used—white imperial porcelain on the main lines and chocolate colored porcelain insulators on the Everett line. The porcelain in the latter was not quite so good as used in the white insulators, and they would not hold up under so high a voltage, even though they were of the same design. The fracture of high grade porcelain shows a vitreous and almost polished surface. The glaze possesses no insulating value, but is simply to prevent the adherence of dust and dirt, and hence it should cover the entire outer surface. High tension porcelain should be thoroughly vitrified and non-absorbent. A test for porosity is obtained by soaking the porcelain in ink; if non-absorbent, the ink should be easily washed off with water.

Spans. The subject of spans in transmission lines has been given considerable attention by engineers in the last few years. During the early days of high voltage work short spans were thought necessary in order to insure against breakage of wires, and as the wires were usually small and the spacing between them not over a few feet, long spans would have given trouble. It has been found, however, that wires never break of their own accord if properly strung and if all kinks are replaced by splices, and that if a spacing of six or seven feet is used there is no danger of the wires swinging together. Large wire having great tensile strength is now used and long spans are operated with safety. The weak point in a transmission line is its point of support, and anything which reduces the number of supports decreases the number of weak points and also the loss from leakage. The great advantage lies in the reduced cost. This reduction in cost, however, will not hold if the length of span is made too great, as it then becomes necessary to build expensive towers and heavy construction in order to take the strain safely. In order to determine the most economical length of span, the procedure outlined by D. R. Scholes is the simplest and may be applied to wood poles as well as to steel towers. A curve is plotted with cost per mile and length of spans as co-ordinates. As an example, let us assume a 55,000 volt line. With spans of one hundred to one hundred and fifty feet, a five-foot spacing between the wires is good practice. A light, malleable

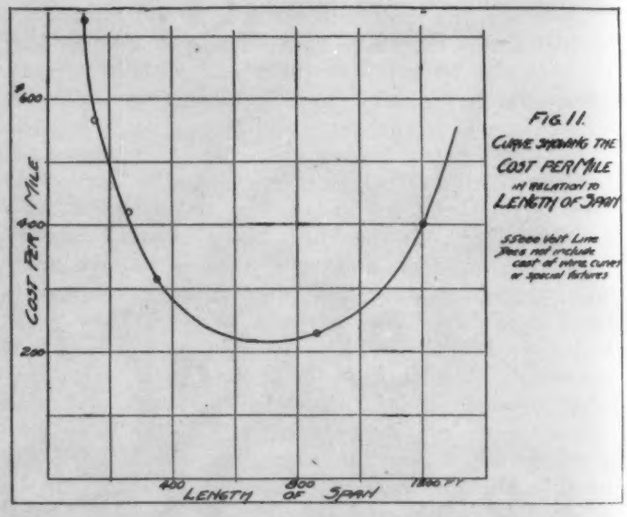


FIG. 11.
CURVE SHOWING THE COST PER MILE IN RELATION TO LENGTH OF SPAN
55000 Volt Line Does not include cost of wire, cutouts or special fixtures

cast iron pin, four by six inch cross arms, and forty-foot poles with eight-inch tops would be used. The labor of setting and framing the pole will vary considerably with the locality, but may be estimated at $6.00. We then have the cost per pole:

3 insulators and pins @ $1.80	$5 40
1 cross-arm, braces, and bolts	0 75
1 40-ft. pole @ 0.10	4 00
Labor	6 00
	$16 15

With thirty-five poles per mile (one hundred and fifty foot spans) this comes to $565.25 per mile, and with forty-five poles (one hundred and eighteen foot spans), $726.75 per mile. For spans of two hundred and fifty to five hundred feet a heavier construction is needed, with a spacing of at least seven feet between wires, similar to the new line of the municipal plant in Seattle. At least fifty-foot poles with ten-inch tops are needed, with five by seven inch cross arms. A substantial design of pin is needed, well fastened to the cross arms. Taking a design similar to that on the city line:

3 insulators and pins @ $2.20	$6 60
1 cross-arm, with braces and bolts	1 20
Pole-top fixture	0 20
1 50-ft. pole @ $0.13	6 50
Labor	6 50
	$21 00

With twenty poles per mile (two hundred and sixty foot spans) the cost will be $420.00 per mile, and with fifteen poles (three hundred and fifty foot spans), $315.00 per mile. This construction if carefully designed can be used up to five hundred or six hundred feet. Although single poles are used for spans up to nine hundred feet in California, the opinion here seems to be that with spans over seven hundred feet an A-frame should be used with double construction. The cost of this may be estimated at:

6 insulators and pins @ $2.20	$13 20
2 cross-arms, braces and bolts, etc.	3 00
2 60-ft. poles	15 00
Labor	11 00
	$42 20

With six poles to the mile (eight hundred and sixty foot spans) the cost will be $253.20. If the line has many bad curves this figure will be considerably increased. With spans over one thousand feet, a four pole tower is recommended. This will cost:

12 insulators and pins	$26 40
Timbers and framing	9 00
4 60-ft. poles	30 00
Labor	25 00
	$90 40

With twelve hundred foot spans the cost will run up to $400.00 per mile, which is past the economical point, as seen on the curve in Fig. 11. These figures are only approximate, and are given chiefly to illustrate the principle involved. The influence of curves, character of country, etc., may make long spans impossible in some parts of the line, which will make the most economical span shorter. On the other hand, a mountainous country affords excellent opportunity for spans from hill-top to hill-top, making a large saving in clearing trees on the right of way, etc. Each particular line must be worked out with reference to the local conditions.

Switching and operation. Some diversity of opinion exists as to the best scheme of switching. The Electron system with two 0000 copper lines and 55,000 volts uses automatic circuit breakers at each end of its transmission lines, and normally these lines are not connected in multiple on the high tension side. A short circuit on the system which lasts only a few seconds will not open the breakers, as the latter are protected by relays; but a short circuit which holds on will open the line at Electron and also at the substation in order to prevent feeding back into the short circuited lines. The Snoqualmie system with 0000 aluminum lines at 30,000 volts has no automatic release on its high tension lines, except where small substations or branch lines tap the main system, and on the switches used for connecting the lines in multiple. A short circuit coming on either line usually releases the multipling switches. The operator at the falls can then usually see from the line ammeters which line the short circuit is on, and opens that line with the oil switch. If for any reason it is not apparent which line is in trouble, the voltage is lowered and the short circuit is "pulled' until it is burned off, but both lines are never cut out. Automatic circuit breakers are used between the steam generating station in Seattle and the transmission system so that the steam plant will not feed back into the short circuited high tension line. This non-automatic method of operation has given excellent results on this system, as most of the line short circuits can be burned off within one or two minutes at the most, and the only effect at the substations is a bad dip in the voltage. This is much better than shutting down for the five or ten minutes necessary to switch out the bad line, as all synchronous apparatus is then thrown out and must be started up and synchronized all over again. Long lines with comparatively small wires are more easily handled in this way. With a short line, high voltage, and very heavy copper a surge may occur with a bad short circuit which will have a destructive effect on the windings of the generators unless their impedance is high. This country is rapidly developing, and within a few years much heavier capacity lines and higher voltages will be employed, and a more complex system with a number of stations tied together will result. More or less automatic apparatus will then become necessary. The plans of the new Seattle municipal system shows the best practice for automatic line protection. They expect to use both overload and reverse current relays in connection with automatic circuit breakers. Unless they are well made, and judgment and care used in their installation and use, the relays may not give satisfaction. The primary object of the relay is to control the automatic release of the circuit breakers. The ordinary overload relay may be set for a certain time limit, and if the overload continues for that time the relay will trip the breaker. If a heavy short circuit comes on the line when there are only a few generators in service, the voltage may be pulled down too low to operate the relay, and the design must be such as to insure operation at very low voltages and power factors. Reverse current relays are used at the substation end of the line to prevent feeding power back into the defective line where two lines are operated in multiple. Relays should open the short circuited line at each end quickly enough to prevent synchronous apparatus on the system from falling out of step; but at the same time they should not operate at slight surges caused by an operator making a slight miss in synchronizing. During the synchronizing of generators at Electron, it is the practice to cut out the relay on the generator circuit breaker so that a bad throw will trip out the incoming machine instantly without disturbing the system. The general conclusion to be drawn from switching practice in the Northwest is that non-automatic operation is satisfactory, and will give good results on systems where the line conductors are not too large and the voltage not over 50,000 volts. In very large and complex systems handling large amounts of power at short distances, automatic protection becomes necessary.

SWITCHBOARDS FOR ROTARY CONVERTERS[1]

BY THEO. F. JACK.

A rotary converter, in construction, is quite similar to a direct current generator, with the addition of collector rings, connected to the armature windings at points having the desired phase relation. The chief applications of a rotary converter (or more familiarly a rotary) is to convert either alternating in direct current, or direct into alternating current, the first application being the most common. When converting A. C. to D. C., a rotary is said to be operating direct; when converting from D. C. to A. C., it is said to be operating "inverted." The modification in switchboards for either case will be discussed later. The frequency of a rotary is determined by the design, as is also the D. C. voltage. The voltages on the D. C.

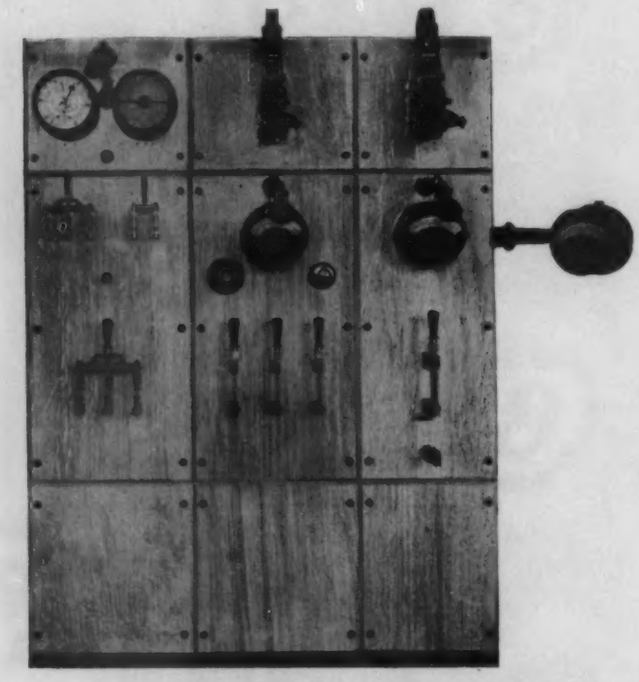


Fig. 1. A Three-Panel Board of Standard Type for the Control of a 3-Phase Rotary Converter.

and A. C. sides differ by a fixed ratio. For circuits of a true sine wave form, this is practically the ratio of the maximum value to the square foot of mean square value of the A. C. wave form. For polyphase machines, there is a difference due to the phases. Rotaries may be either shunt or compound wound, the latter being the most common.

From a switchboard point of view, a rotary converter is considered as two separate machines, namely, a direct current generator and a synchronous motor. It is customary to provide separate panels for each side of the machine. Panels for controlling units of 100 k. w. or smaller, may be combined into one panel, also panels for larger units, where the A. C. side is controlled by electrically or mechanically operated remote control switches. The most general and satisfactory method is to provide separate panels. These are usually built up so as to form a complete board, with the A. C. panels on one end and the D. C. on the other. This arrangement keeps the A. C. and D. C. circuits separate and avoids crossing of leads or bus bars.

Fig. 1 shows a standard type of rotary converter switchboard, such as would control a 500 k. w., 3 phase, 550 volt, D. C. machine. Fig. 2 is the diagram of connections applying to this board. The A. C. panel contains an ammeter with its switches, a power factor meter, starting motor switch, synchronizing rheostat switch, main switch and synchronizing lamp, plug and receptacle. An A. C. voltmeter is seldom furnished, as the A. C. voltage can be quickly calculated from the D. C. as shown on the D. C. voltmeter.

Referring to the diagram, it will be seen that the alternating current passes through a bank of delta

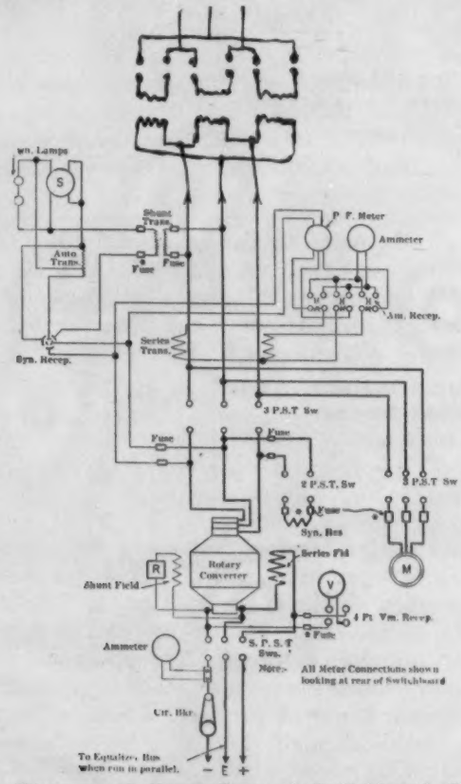


Fig. 2. Diagram of Connections of Switchboard Shown by Fig. 1.

connected, lowering transformers, connection being made to the machine by the three pole, S. T. main switch on panel. It is good practice to connect transformers, when serving rotaries, in delta, both on high and low tension sides, as such an arrangement facilitates the cutting out of one transformer in case of trouble or repairs. Sometimes switches are provided on both sides, being connected inside the delta, so as to facilitate the speedy isolation of any transformer.

Where it is desirable to operate rotaries in parallel, they should be bussed on the D. C. side only. Each machine should have its own bank of transformers, and although several banks of transformers may be bussed on the high tension side, a similar arrangement on the low tension side should be avoided. It is impossible to operate rotaries on parallel satisfactorily and equalize the load when bussed on both A. C. and D. C. sides. There have been cases where it was thought desirable to bus the low tension side of all transformers and operate the rotary in parallel with both A. C. and D. C. bus bars, but, in order to obtain

[1]Paper read before Seattle Section of American Institute of Electrical Engineers, February 20, 1909.

satisfactory results, it was necessary to insert specially designed choke coils in series with each A. C. machine lead. The purpose of those choke coils being to retard the flow of correction currents, which would otherwise exchange between unequal machines. The insertion of these choke coils lowers the efficiency of the converter group, as well as affecting the power factor and compounding.

It is customary to connect each rotary to its bank of transformers, with a main switch for interrupting the circuit. Sometimes this switch is located in the high tension leads to the transformers, the low tension leads being connected solid to the machine. This is desirable, if the units are of large capacity. In order to save cable the banks of transformers are placed as close as possible to their respective machines. With such an arrangement, considerable cable can be saved, especially if the machines are six phase and of large capacity. It is recommended that a small slab, holding two single pole switches and mounted close to transformer be provided for the low tension side, so that any transformer may be isolated, or the entire low tension circuit opened. This is necessary if the machine is started from the D. C. end and it is desirable to reduce the starting current to a minimum, otherwise excessive current may flow, due to the magnetizing current required by the transformer secondaries.

Automatic protection in the low tension A. C. circuit is very seldom required, and rarely provided. The circuit breaker on the D. C. side affords ample protection for the machine, and fuses or a circuit breaker in the high tension leads give the desired protection to the transformers. If sufficient care is exercised in running the low tension A. C. leads, there is no necessity for placing automatic cutouts or fuses in the circuit. Where a system, as shown by Fig. 3, is used, an automatic feature should be added to the oil circuit breaker.

The only indicating instruments required on the A. C. panel, are an ammeter and a power factor meter. One ammeter is sufficient for polyphase machines, as the phases are normally balanced. Suitable ammeter switches should be provided, so that readings of each phase can be obtained. These switches should be so designed as to not open the series transformer circuits when operated. A power factor meter is preferable to an indicating wattmeter, as it enables the attendant to properly adjust the field strength with regard to power factor and avoid calculations, which obtain when a wattmeter is used.

The armature of a rotary converter is usually brought to synchronous speed before paralleling, that is, if the method of starting selected requires synchronizing. This is usually done by means of an induction motor, the motor being direct connected to the armature shaft, and in systems similar to Fig. 2, is controlled by a single throw switch on the A. C. panel. In earlier designs, a double throw switch was provided for this purpose, connecting the motor to the starting and running voltages required. This method has been greatly simplified by designing the motor windings so it could be thrown on full voltage when starting. Sometimes D. C. starting motors are used, also single phase series motors, the latter being required with four pole rotaries.

In addition to the starting motor, a resistance load should be supplied, to act as a brake and slow down the acceleration of the rotary's armature, so that it may be more readily synchronized. This resistance, usually of inductive type, is called a synchronizing resistance and is controlled by a two pole, S. T. switch on the A. C. panel. Some engineers insist on a field switch being added to the board, so that in case the machine is built up with the wrong polarity, this field switch can be opened and closed quickly, allowing the armature to "slip a pole" and give the correct polarity on the D. C. side. The disadvantages of this field switch are greater, however, than its advantages, chief among the dangers being the possibility of its being opened at the wrong time.

It is customary to omit the field switch and if the machine has the wrong polarity, the operator opens the A. C. switch and resynchronizes till the machine is of the proper D. C. polarity.

For synchronizing purposes, either lamp or the synchroscope can be supplied, and it is good practice to furnish both. The lamp serves as a check on the synchroscope and as a means by which the speed of the incoming machine may be judged, the synchroscope giving an indication of the point where the frequencies of the incoming machine and the line coincide and indicating to the operator the proper instant for closing the main switch. Synchronizing with the lamp alone is very unsatisfactory and unreliable, which is more apparent the larger the unit to be thrown in step. There are two ways of connecting the synchronizing lamp, called "dark" and "light" methods, depending on whether the lamps are to be dark or bright at the point of synchronizing. Of the two, the dark method is to be preferred, as giving more accurate results.

The use of synchroscope for throwing A. C. machines in step, is much more satisfactory than lamps. The synchroscope indicates clearly the exact point of synchronizing, and any difference in frequency which would not be shown by lamps is clearly indicated by this instrument.

There is on the market an instrument which will automatically synchronize an A. C. generator or rotary converter, and perform the operation without failure or disturbance to the distributing system. This instrument is so designed that it will not throw the incoming machine in circuit unless both the frequency and voltage are correct. One automatic will serve any number of machines. Its use eliminates all the chances for error inherent with manual operation, and for large installations, is well worth the extra expense. The use of an automatic synchronizer necessitates the use of electrically operated switches in either the high tension or low tension leads of the lowering transformer. In most cases, it is cheaper and simpler to install the electrically operated switch in the high tension leads, although instances may develop where it is necessary to place electrically operated switches in the low tension leads. Fig. 3 shows a switchboard provided with automatic synchronizer. The A. C. panel containing automatic synchronizer and controlling apparatus is shown as the first panel at the extreme left of the board, and it will be noted that the D. C. end is arranged for controlling the positive side

only of the machine. The negative and equalizer busses would be placed near the machine, as will be hereinafter explained.

Methods of starting and paralleling without synchronizing are in use, and some are giving excellent satisfaction. The elimination of synchronizing with its attendant evils, is much to be desired, especially where a number of units are paralleled daily. Of these methods, we will discuss two that are in use.

In the first of these the A. C. panel is the same as shown by Fig. 1, except that the starting motor switch, synchronizing switch and synchronizing lamp and receptacle are omitted. A separate starting panel is provided and placed conveniently near the machine and switchboard. This panel contains, for a three phase or a six phase rotary, two three P. D. T. or six S. P. D. T. switches. These switches are connected to certain taps, provided on the lowering transformers, so

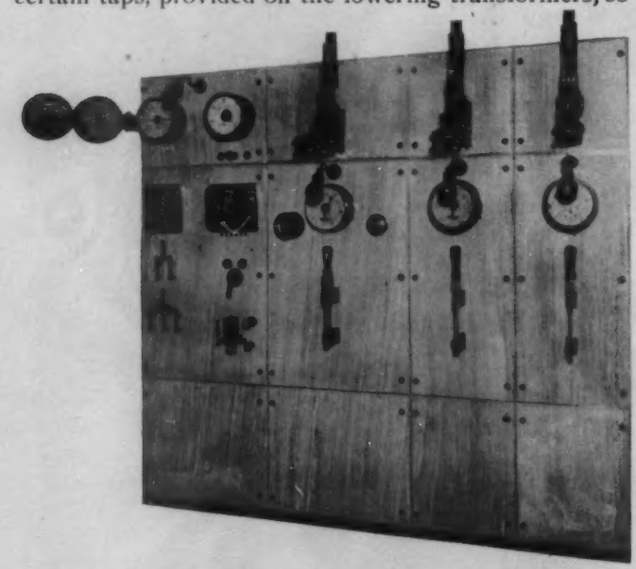


Fig. 3. Three-Panel Rotary Converter Board With Automatic Synchronizing Apparatus Mounted on A. C. Panel.

that three different voltages may be impressed on the rotary's armature in starting. Two field switches are provided—one, a two pole switch, is mounted on the A. C. panel, the other, a four pole switch, is mounted in the frame of the machine, being so connected that, when open, the shunt field coils are disconnected in groups. This is necessary on account of the high voltage induced in these field coils by the powerful rotating field obtained in starting. To start, all switches are opened; the A. C. switches giving the lowest starting voltage are closed, and as the armature increases its speed, the other voltages are thrown on in succession. When full speed has been reached, both field switches are closed and the usual method of putting the machine on the D. C. bus is followed.

This scheme works out fairly well for small units, but for large ones, has the following disadvantages:

First. Additional cost of taps on lowering transformers.

Second. Additional wiring and switching.

Third. Heavy starting current required, unless the machines are provided with prohibitively light dampers.

The last named is to be seriously considered in the case of large units. In order to decrease the starting current, light damping grids must be used on the pole tips. This decreases the ability of the machine to stay in step on overload, also increasing the inherent characteristics of the rotary to hunt.

With the second method, the A. C. panel is the same as Fig. 1, except the main switch is special double throw and the motor starting switch, synchronizing rheostat switch and synchronizing lamps, plug and receptacle are omitted. Three resistances (preferably of ohmic type) are furnished for the A. C. side, being connected so as to be in circuit when the main switch is thrown half way in. They are of sufficient capacity so as to limit any passing current to the normal running current of the rotary. A starting switch and resistance are furnished on the D. C. panel, and means are provided for separately exciting the shunt field. To start, all switches are opened, the D. C. circuit breaker is then closed, then the negative switch and the starting switch. Throwing the starting switch on the first point connects both shunt field and armature to the circuit, the field being connected so as to receive full voltage. This arrangement not only simplifies the board by omitting the field switch, but eliminates the possibility of the attendant throwing the armature in circuit without first exciting the shunt field. The synchronizing rheostat may be thrown in circuit after the armature starts to revolve.

When the armature has attained synchronous speed, the main A. C. switch is thrown in the first position. This connects the rotary to the A. C. circuit through a resistance. If the rotary and line are out of phase, a corrective current will flow at the instant of throwing the switch. This current will pull the armature into step and lock it there. The value of this corrective current depends on the difference in phase and voltage of the line and rotary at the instant of closing the circuit, but it is limited at any time to full normal current of the armature by the resistance in circuit. When the armature has fallen in step, the main switch can be thrown to the running position, in which position the resistance is short circuited. In using this method of starting, it is advisable to adjust the rotary so that its frequence will be slightly above that of the A. C. system before the A. C. circuit is closed. This will permit the armature to fall into step with a minimum exchange of current. The armature can be thrown in on the A. C. circuit at speeds lower that synchronous, but a greater corrective current will flow; also stress will be placed on the field coils by the shifting field which may cause damage.

While this method has the disadvantages of all methods of starting from the D. C. end, in that it requires a source of direct current to start, it does not have any of the disadvantages mentioned of the scheme shown by Fig. 4 and has advantages which will prove attractive when direct current for starting can be obtained.

The direct current side of a rotary may be controlled by a panel such as would be furnished with a similar D. C. generator. Referring to Figs. 1 and 2, you will note that the D. C. panel contains a single pole automatic overload circuit breaker, an ammeter, voltmeter, voltmeter plug switch, field rheostat and main switches. Where a number of large rotary converters are to be operated in parallel, the question of automatic protection on the D. C. side should be given careful attention. It is often advisable to add

to the regular overload circuit breaker, a reverse current trip and an overspeed trip. The reverse current feature should be as sensitive as possible, preferably of the shunt operated relay type, and should trip the breaker on any reversal of current on the D. C. side. The overspeed device should be attached to the end of the armature shaft and so adjusted that the centrifugal action of any speed above normal would close a tripping circuit and open the breaker.

The D. C. meters should be of the polarized type and so connected that they will indicate only when the machine is built up with the proper polarity. Where a number of units are to be installed, it is recommended that the D. C. panel contain an ammeter only, the voltmeters being placed on a swinging bracket at the end of the board.

The field rheostat is usually mounted on the D. C. panel on account of lack of space to place it on the A. C. panel where it really belongs. Having the rheostat on the A. C. panel is a convenience to the operator, enabling him to more easily read the power factor meter when adjusting the field. Where the A. C. and D. C. panels form separate boards, removed from each other, it is advisable to place the field rheostat on the A. C. panel.

With installations of small units, the positive, negative and equalizer switches may all be mounted on the D. C. panel, with busses on rear, or the equalizer switch may be placed on a pedestal located near the machine with the equalizer bus run between pedestals, under the station floor. In any case, it is preferable to use single pole switches, so that the series field can be thrown in circuit and partly excited before the machine is connected to the bus. For large installations, of 500, 1,000 or 1,500 kw. units in railway installations, a single bus system for the D. C. panels can be used to great advantage and a considerable amount of cable thus saved. With this system, the board controls the positive circuit only, requiring but one bus bar and one polarity on the rear of board.

The negative and equalizer circuits are controlled by switches placed on suitable pedestals near the machine, a circuit breaker being provided in addition to the switch for the negative circuit, and equalizer bus bars can be located beneath the station floor and if possible directly under the pedestals and machines. This reduces to a minimum the length of negative and equalizer cable, necessary to make connections to bus bars. A switch board of this type is shown by Fig. 3, from which you will note the simplicity of arrangement of the D. C. panel resulting in a saving in cable, ducts and losses.

It is sometimes advisable to start from the direct current end and avoid the additional expense of either A. C. or D. C. starting motors. This may be worked to great advantage in handling of large units. To accomplish this, the switchboard is so arranged that the rotary may be started as a shunt wound motor. With compound rotaries, this may be easily accomplished by arranging connections so that the starting current on the series field side will flow through the equalizer lead with the series field out of circuit. The source of starting current may be obtained from the D. C. bus bars, when there are other machines running, but this brings out this disadvantage, in that it is necessary to provide at least one rotary with a starting motor to get it in operation before the others can be started. In some cases the starting current can be obtained through the trolley from another station. The best arrangement is to install a small motor generator set to provide the starting current. If this is done, the switchboard should be laid out with a separate bus for starting current and a special or "starting" panel, by which this current can be controlled. If the units are all of the same capacity, one starting switch and resistance will be sufficient. The negative and equalizer switches can be made double throw, for making the starting connections. The circuit breaker on the starting panel can afford protection in starting, and an ammeter in the same panel should indicate the current value of the starting circuit.

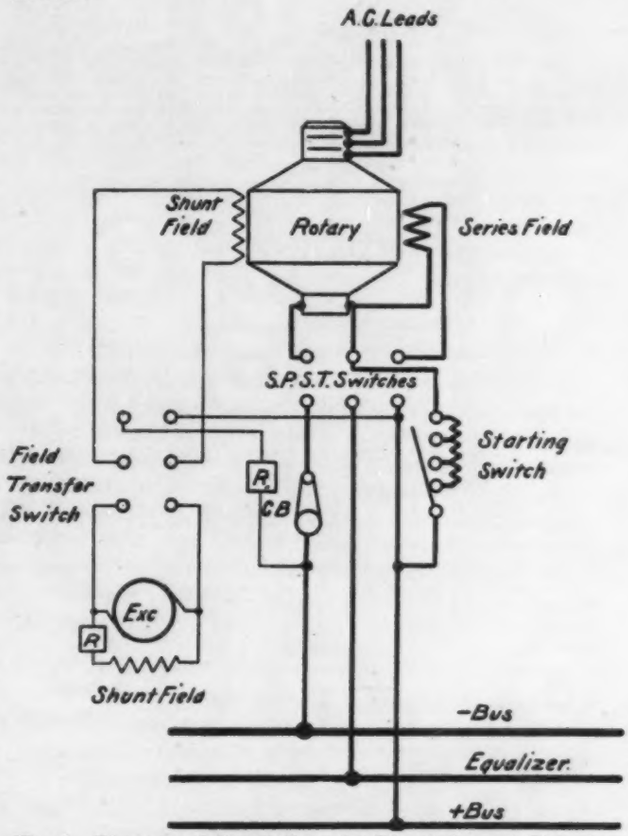


Fig. 4. Diagram of Connections for Direct Current End of an Inverted Rotary Converter.

Switchboards for control of rotaries operating inverted, or periodically direct and inverted, differ from the ordinary board, chiefly in the arrangement of instruments on the D. C. panel. Fig. 4 gives an idea of the switch connections of the D. C. end of a 300 kw., 550 volt, 3 phase, inverted rotary. The A. C. panel is the same as Fig. 1, but the D. C. panel contains a field transfer switch, exciter, rheostat and starting switch in addition to the regular complement of D. C. instruments. The field and starting switches are used in starting. The rheostat in the converter field is used only on starting, and when the machine is running, this rheostat should be cut out, field regulation being obtained through the exciter field rheostat.

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CONTENTS

Electricity at the Exposition.....*By J. S. Harisberger* 315
Cactus Sap as a Rubber Substitute..... 317
Notes on Transmission Practice in the Northwest.....
.....*By Mangus T. Crawford* 318
Switchboard for Rotary Converters.....*By Theo. F. Jack* 324
Editorial 328
Electricity in the Northwest.
Current Comment 329
Electrification of the Northern Pacific Railway.
Another Substitute for Rubber.
Electrical Stimulation of Wheat.
Nitric Acid from the Air.
Electric Sights on Rifles.
A Mono-Rail System.
Wireless Communication Across the Pacific.
A Merger of Washington Power Companies.
Sunspots.
Tokyo Electric Light Company.
American Electro-Chemical Society.
Electric Power for the Homestake Mine.
A 50-Inch Spark-Producer.
Amalgamation of Japanese Electric Firms.
Electric Power Plant for Bogato, Columbia.
Personal 330
Northwest Electric Light & Power Association..... 330
Book Reviews 331
"High Tension Underground Electric Cables."
"Electric Lamps."
"The Theory of Electrc Cables and Networks."
Annual Meeting of the Electrical Trades Association..... 331
Patents 332
Industrial 333
A New Bell-Ringing Transformer.
General Electric Exhibit at A. Y. P.
Trade Notes 333
Trade Catalogues 333
News Notes..... 334
Spring Meeting of the American Society of Mechanical Engineers. 336

Electricity in the Northwest

The Pacific Northwest is inviting the world to view the great strides that have been made in converting what but recently was a trackless wilderness into one of the most productive regions of the earth. Youth such as this, has no historical event to be commemorated. Therefore, the purpose of the Exposition to be held at Seattle during the coming summer is primarily one of education. The exhibits are the great natural resources with which this region has been so lavishly supplied. Fertile lands, dense forests, productive mines, streams teeming with fish and supplying abundant water for power and irrigation, all afford lessons of unparalleled interest to those whose lands have long been stripped of these bounties of Nature.

The water, last named, because most recently used, is capable of the greatest development, and on its wise utilization depends the material prosperity of these people. As an irrigator it is bringing forth the raw products, as a power source it is turning the wheels of industry. Within less than a decade the futile roar of the waterfall has been supplanted by the busy hum of the generator, and the power waste of multitudinous streams harnessed to the needs of man. In Rainier's glaciers on the summit of the Cascades is locked the potential energy to furnish the myriad of lights of this Exposition, to transport its visitors and to perform the many duties demanded by this service.

The region has also its coal measures, this fuel being more plentiful here than elsewhere on the Pacific Slope. There are many small electric power plants as well as auxiliaries to the larger ones that are operated by steam.

The key that has unlocked this great storehouse of Nature is the enthusiasm of its people as backed by the monied men of the country. This spirit of zealousness is indicated by the active existence of the Northwest Electric Light and Power Association, which is co-operating with the Seattle section of the American Institute of Electrical Engineers in extending a hearty welcome to visiting electrical men. The high standing of the latter is attested by the excellent papers that have been read before it and published in our columns. These two bodies are desirous of letting the world know the capabilities of their section. They will have a joint meeting at the Exposition early in September and invite all electrical men to plan their trip for that time. Oregon, Washington, Idaho, British Columbia, and Alaska will have representatives to show the power possibilities of their respective districts, and it behooves those of us who have not yet learned it all to be there.

CURRENT COMMENT

Electrification of the Northern Pacific Railway on the Montana division is being investigated.

Another substitute for rubber for insulation purposes is claimed in the wax obtained from the candelilla plant in Mexico.

Electrical stimulation of wheat increased the crop from 26.15 to 37.5 bushels per acre in some recent experiments in England.

Nitric acid from the air is to be obtained by four plants in Norway which will be completed by the end of 1910. These plants will use the Birkland-Eyde process.

Electric sights on rifles are being tried out at the arsenal at Springfield, Mass. Small electric lights, supplied with current from a storage battery, illuminate the rifle sights so that accurate aim can be taken in the dark at close range.

A mono-rail system is to be installed by the Pelham Park & City Island Railroad Companies between Bartow Station and Beldon Point, the Bronx, New York City. The system is purely experimental and will employ electric power.

Wireless communication across the Pacific was maintained constantly during the latest trip of the army transport Sheridan, which was in direct communication with San Francisco until it reached the 180th meridian when communication had been opened with Honolulu. Off Midway Island conversation was conducted with Nagasaki, 2,800 miles, and Honolulu.

A merger of Washington power companies is to be effected by the Puget Sound Power Company, which has been incorporated with a capital of $80,000,000 as a holding company for all the electric light, power and railway companies in northwestern Washington. Extensions are planned that will give continuous electric railway service between Portland, Oregon, and Vancouver, British Columbia.

Sunspots are vortices of negative electricity in the atmosphere of the sun, according to Dr. Geo. E. Hale, director of the Carnegie Solar Observatory at Mount Wilson, California. The cathode rays, or particles of negative electricity emitted by the vapors of incandescent metals, produce a magnetic field if they are whirled around. These have been recognized in the spectra of the sun and are evidently closely identified with the earth's magnetic field.

The Tokyo Electric Light Company intends to establish a second power station. The work of construction is estimated at $5,000,000 gold, and it is believed that the station, when completed, will be capable of supplying electric current to the extent of 35,000 horsepower. The power of the company is at present 22,500 horsepower, of which 18,000 horsepower is supplied to the general public. Altogether, the company will shortly be able to supply 57,000 horsepower to the public.

The American Electrochemical Society will hold its annual meeting at Niagara Falls, Canada, on May 6, 7 and 8. In addition to a number of papers on electrochemical analysis, there will be presented a symposium of papers on the electrometallurgy of iron and steel by various experimenters.

Electric power for the Homestake Mine at Deadwood, South Dakota, is to be furnished by a 5000 k. w. hydro-electric plant, which will be erected on Spearfish creek. A fall of 700 feet is to be obtained by conveying the water through underground tunnels for over five miles. These tunnels, eight in number, will each be from 2000 to 4000 feet long.

A 50-inch spark is produced by the Heinze induction coil which has recently been produced for experimental work. The primary core is 6 feet in length, 4 inches in diameter and weighs 210 pounds; it consists of 748 turns of No. 16 magnet wire. A 10-foot micanite tube, 1½ inches thick, forms the insulation between the primary and secondary. The latter consists of 138 miles of No. 32 magnet wire wound on a series of mica-insulated coils. The commutator is motor-driven and designed so as to allow no inductive "back kick."

An amalgamation of Japanese electric firms, the Shibaura Seisakujo factory of the Mitsui family with a capital of $500,000 and the Tokyo Electric Company may be made by the General Electric Company and Japanese capitalists, with a paid-up capital of $350,000. The conditions of the amalgamation are not yet known, but it is believed that the capital of the amalgamated company will be increased to $2,000,000, 51 per cent of the shares being allotted to the American company in consideration of the acquirement by the new company of all the patents owned by the General Electric Company.

An electric power plant for Bogota, Columbia, is proposed, according to Consul-General Jay White. At present the streets of Bogota are not lighted, because the electric company, which has its power station 20 miles from the city, has not sufficient power to supply the necessary electricity for both house and street lighting. The site of the new plant is three miles from Bogota, and 656 feet above the level of the city. The city could be well lighted with 250 arc lamps or with 25 arc lamps and 1,000 25-candlepower incandescent lamps. The cost for the installation of these systems is estimated as follows: The all-arc-lamp system, about $47,000; the arc and incandescent system, about $42,000. If, as it is said, the government offers about $25,000 per annum for lighting the streets, the contract for building the new installation should be a good business for a small company. In addition to the offer of the government for street lighting, it is estimated that a yearly income of $10,000 would be derived from renting power to private parties. Deducting the working expenses, this would leave an annual net revenue of over $24,000.

PERSONAL.

H. B. Logan, president of Dossert & Co., New York is in San Francisco.

John G. Sutton of the John G. Sutton Company, San Francisco, returned Monday from Vancouver.

Frank T. Clarke, formerly with the engineering department of the Commonwealth Edison Company, Chicago, is now with the Pacific Gas and Electric Company, San Francisco.

B. L. Kerns has been placed in charge of the Spokane, Wash., branch of the Westinghouse Electric & Manufacturing Company, after six months service in the Seattle office.

Robert F. Beebee, proprietor of the Gridley Electric Light and Power Company, at Gridley, Cal., was killed April 13th at the power house by coming in contact with a 15,000 volt wire.

H. C. Thaxter, former manager of the Standard Electric Works, San Francisco, is now connected with the engineering department of the San Francisco office of the Allis-Chalmers Company.

T. E. Bibbins is now assistant Pacific Coast manager for the General Electric Company with headquarters in San Francisco, having been advanced from the position of manager of the supply department.

F. H. Poss, of the San Francisco office of the Holophane Company and the Benjamin Electric & Manufacturing Company, has returned from a trip of four weeks which included Seattle, Vancouver, Salt Lake City and Los Angeles.

F. L. Pierce, vice president of the Cutler Hammer Manufacturing Company, Milwaukee, Wis., has been spending several weeks in Southern California and expects to reach San Francisco on his return trip to the East about April 28, 1909.

Robert Kuhn, secretary of the American Electrical Heating Company, Detroit, Mich., spent the past week in San Francisco, and left for Del Monte on Friday, where he will attend the meeting of the Electrical Jobbers' Association of the Pacific Coast.

S. G. McMeen, engineer for the Home Telephone Company, San Francisco, will deliver the second annual address before the chapter of the Tau Beta Pi at the University of California, on May 5, 1909. He will speak on the development and application of the telephone.

J. W. Perry, general manager of the electrical department of the H. W. Johns-Manville Company, with headquarters at New York, spent the past week in San Francisco on his annual trip to the Pacific Coast. On April 15th he was the guest of the Electrical Club of San Francisco at luncheon when, in response to the request of the president he reviewed conditions in the electrical business as he has found them on his present trip.

O. J. WAKELING, WITH THE CALDWELL BROTHERS COMPANY, SEATTLE, WASH.

The Journal takes pleasure in introducing to the machinery trade of the Northwest, a young business man from San Francisco, whose capabilities should be of material assistance in furthering the prosperity not only of the company with which he is connected, but also of the region which it is supplying. Mr. O. J. Wakeling has resigned his position with Baker & Hamilton of San Francisco to become general sales manager for The Caldwell Brothers of Seattle and Tacoma, Washington. This firm carries one of the most complete lines of machinery in the Northwest, including steam engines and boilers, machinery tools, mining machinery of all kinds, hydraulic equipment, contractors' supplies, sawmill and woodworking machinery, representing many of the best manufacturers in the various lines. Among these are the Dodge Manufacturing Company, Buffalo Steam Pump Company, Ballwood Automatic Engines, A. S. Cameron Steam Pump Company, Cambria Steel Company, English Iron Works, Gould Manufacturing Company, Houston-Stanwood & Gamble Company, Hendrie and Bolthoff Manufacturing and Supply Company, Ingersoll-Rand Company, La Blonde Machine Tool Works, Pennsylvania Boiler Works, Regal Gasoline Engine Company, Risdon Iron Works, Riffe Hydraulic Engine Manufacturing Company, Taylor Iron and Steel Company, Wellman, Seaver, Morgan Company.

O. J. Wakeling.

Mr. Wakeling, by virtue of his wide and varied experience, supplemented by his long service in charge of the machinery department and engineering work of Baker & Hamilton on the coast, is eminently qualified for his new position. After graduating from the Department of Electrical Engineering at McGill University, he entered the employ of the Michigan Electric Company of Detroit, Michigan. Later he was with the Kendrick Gold Mining Company in South Carolina and Alabama, and then with the Richmond Railroad Company on Cape Breton Island. After a year's service with the Salt Lake Electric Company he entered the employ of Baker & Hamilton of San Francisco, which position he has just left with the good wishes of his many friends for his continued success.

NORTHWEST ELECTRIC LIGHT AND POWER ASSOCIATION.

The annual convention of the Northwest Electric Light and Power Association will be held at the Alaska-Yukon-Pacific Auditorium September 7th, 8th and 9th. The executive committee at a recent meeting at Spokane outlined the program for the convention and it is intended to procure at least two speakers of national prominence in the East to prepare papers on live topics. They have also decided to join with the Seattle section of the American Institute of Electrical Engineers and by judicious publicity are trying to induce all electrical men who are coming to the exposition to plan their trip for that date.

The Association will have commodious headquarters in the Manufacturers' Building at the fair which will be kept open during the entire period of the fair. These rooms will be used primarily as the headquarters and resting room for all electrical men who visit the fair and the Association plans to have complete sets of views showing the various plants, power stations, etc., of all the member companies, together with data in pamphlet form concerning their development, business, etc.

BOOK REVIEWS.

"High Tension Underground Electric Cables," by Henry Floy, M. A. M. E, 135 pages, size 5x7½ inches, with numerous tables and diagrams. Electrical Publishing Company, 165 Broadway, New York, and Technical Book Shop, San Francisco. Price, $2.00.

This book is a record of experience gained in the design and equipment of several important underground installations for high-tension work. The author is well qualified to write on the subject of high-tension sub-surface transmission, and his statements are of value to all those concerned with putting wires underground. The advantages of this type of construction are detailed and numerous examples of its successful operation quoted. The latter includes several 25,000 volt installations. A full description is given of the various insulating materials, including an account of their manufacture, their faults, their good points, specifications and tests. Recognizing the unsatisfactoriness of the usual empirical formulae for determining the proper insulating thickness of wire, the author has compiled a number of tables giving this data for several materials at various voltages. Curves, tables and data are presented relative to the heating and testing of cables, as well as formula to be used in electrical calculations. The book concludes with a chapter on the costs of underground installations with practical reference to the price of cables. The author states that it is fair to assume that cable manufacturers can furnish and guarantee three-conductor cables as large as 0000 B. & S. for tensions as high as 35,000 volts. It is unusual to find a book embodying the results of so much practical experience, and for this reason it is of value to the man who is doing such work.

"Electric Lamps," by Maurice Solomon, 319 pages, size 5½x8 inches; 112 diagrams. D. Van Nostrand Company, 23 Murray street, New York, and Technical Book Shop, San Francisco. Price, $2.00.

This volume brings into compact form information regarding various kinds of incandescent and arc lamps. The author's practical experience in the manufacture of several types is evinced by the publication of matter not found in the usual catalogues. A discussion of the principles of artificial illumination and a theoretical treatment of the production of artificial light precedes the chapter of photometry and methods of testing, the latter being particularly complete. Next the author takes up carbon-filament lamps and metallic filament lamps, giving in each case a historical summary of the method of manufacture, physical characteristics and life. The section devoted to the electric arc is equally complete. Under miscellaneous lamps are described the magnetite arc, the mercury vapor lamp and the Moore vapor lamp. The concluding chapter is devoted to a comparison of lamps of different types. The author's comparisons and criticisms seem fair and unprejudiced and are of material assistance in deciding what type of lamp is best fitted for any practical requirement.

"The Theory of Electric Cables and Networks," by Alexander Russell, M. A., D. Sc.; 265 pages, 5x8½ inches, 71 diagrams. D. Van Nostrand Company, 23 Murray street, New York, and Technical Book Shop, San Francisco. Price, $3.00.

Mr. Russell is the author of "A Treatise on the Theory of Alternating Currents," is a member of the Council of the Physical Society and of the Institution of Electrical Engineers. He has contributed many valuable papers on the theory of electrical conductors and in this volume brings into compact form much interesting material. After a general explanation of fundamental electrical principles and a description of the various gauges in use for specifying wire, the book may be broadly divided into two subjects, treating respectively of conductivity and insulavity. The use of this latter expression is not recognized by the usual dictionary, but as it includes the subject of insulating material for both high and low tension cables, it seems justified. These main divisions are further sub-divided into low and high tension requirements. In the second chapter special attention is given to the effect of the "lay" on the weight and conductivity of stranded cables. Much space is given to the design of distributing net works. Formulae are developed for calculating not only the current transmitted, but also the insulation necessary. The author makes an excellent distinction between the requirements of low tension cables, that the insulation be such as offers the greatest resistance to the flow of electricity, and for high tension work that the insulation offers a resistance to the disruptive discharge. Consequently the wrappings suitable for low tension cables may not be suitable for high tension, and vice-versa. The text contains valuable theoretical discussion on dielectrics, from which the author deduces a number of physical constants. Further chapters deal with grading and heating of cables. In conclusion he illustrates and describes a few types of lightning arresters. The text is essentially a mathematical treatment, illustrated by numerous practical examples. It has been written more particularly in accordance with the requirements of English practice and refers constantly to the wiring rules of the English Institution of Electrical Engineers and the Board of Trade. These differ in some few particulars from the standard established by the Board of Fire Underwriters in this country, but the difference is so trifling as to make but little difference in its use here. The lack of a comprehensive summing up of formulae is partly obviated by the excellent index and convenient system of paragraph captions. It will prove of little use to the ordinary electrical contractor, but to engineers interested in insulation of high tension cables it should be invaluable.

ANNUAL MEETING OF THE ELECTRICAL TRADES ASSOCIATION.

The annual meeting of the Pacific Coast branch of the Electrical Trades Association was held at the Hotel Argonaut, San Francisco, on Saturday, April 17th.

Forty members and guests enjoyed an admirable luncheon followed by some brief speeches, the annual reports submitted by the retiring orficers, and the election of new officers for the ensuing year.

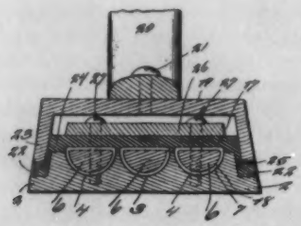
H. F. Frosch, president of the Electrical Club of San Francisco spoke briefly of the advantages of such a club and reviewed its past history. E. M. Scribner of the Journal of Electricity talked on the subject of the press and called attention to some of the existing conditions in journalism which might offer an opportunity for some reform work on the part of the electrical trades generally. W. H. Hanscom of the Century Electric Construction Company of San Francisco read a very interesting paper relative to the relation of the Trades Association to the electrical construction business. He submitted for inspection a number of old time devices collected by him during the past few years which were remarkable as an example of what electrical material should not be.

Frederic P. Vose of Chicago, National Secretary of the Association, spoke in detail of the work the Association has done in the past and congratulated the Pacific Coast branch on the good work which has been done in this section. The information given by him, based upon his national experience in this work was of unusual interest.

The following officers were elected for the ensuing year: President, A. E. Drendell of the Drendell Electric & Manufacturing Company, San Francisco; vice-president, R. F. Behan of the San Francisco office of the Westinghouse Electric & Manufacturing Company; executive committee, John R. Cole of the John R. Cole Company; C. C. Hillis of the Electric Appliance Company; Samuel H. Taylor of the Electric Railway & Manufacturers' Supply Company.

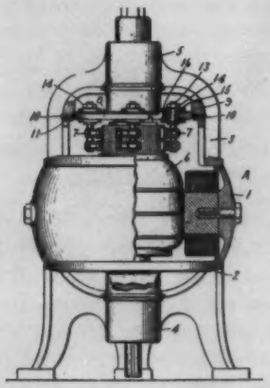
PATENTS

916,994. Electric Heater. George W. Carpenter, John Rasmussen and Frederick B. McCroskey, Ontario, Cal. In an electric heater, a body portion having rounded grooves in its



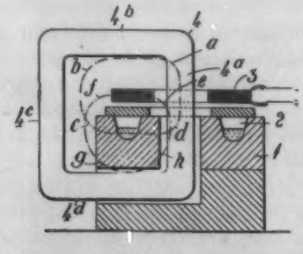
upper face, and cores disposed in said grooves, siad cores having flat upper faces and rounded under surfaces conforming to the shape of the grooves.

917,005. Brush Support for Dynamo-Electric Machines. Walter M. Coffman, Madison, Wis., assignor to Northern Electrical Manufacturing Company. In a dynamo-electric machine, a bonnet at one end thereof, a brush-supporting ring having



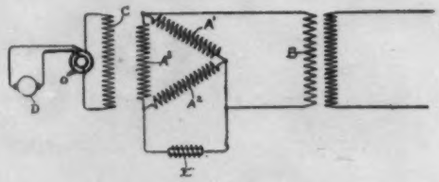
a beveled outer edge, a shoulder in said bonnet against which the outer portion of the rings bears, and a screw carried by said bonnet and engaging said beveled edge of the ring for forcing it against the shoulder.

917,040. Electric Transformer Furnace. Otto Frick, Saltsjobaden, Sweden. An electric induction furnace comprising a masonry base with an annular hearth for the material to be treated forming the secondary circuit of the furnace, a primary winding facing a horizontal side of the



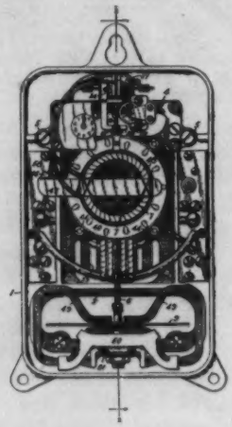
hearth, and a closed magnetic core, one limb of which is surrounded by the hearth and by the said primary winding and the other limbs of which are at such distance from the said winding that a free space is left between the iron and said winding.

917,181. Single-Phase Alternator. Charles P. Steinmetz, Schenectady, N. Y., assignor to General Electric Company. In combination with a synchronous single-phase alternator and its load-circuit, an energy storing device, and connections from the armature winding of said alternator to said device



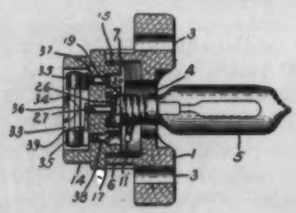
for impressing on said device a voltage displaced in phase from the terminal voltage of the alternator by an angle approximately equal to forty-five degrees plus one-half the average angle of lag in said load-circuit, said device being designed to receive a volt-ampere input approximately equal to the average volt-ampere load on said alternator.

917,130. Meter. William H. Pratt, Lynn, Mass., assignor to General Electric Company. In a meter, a spherical armature having an air core, and a pair of circular field coils each



consisting of a plurality of concentric coil sections, said field coils closely encircling the armature and mounted close together to reduce the number of stray lines of force.

917,229. Receptacle for Incandescent Lamps. Herbert C. Wirt, Schenectady, N. Y., assignor to General Electric Company. In a lamp receptacle, the combination with stationary contacts, of an insulating block having on one face lamp



engaging terminals and contacts for engaging the stationary contacts and respectively connected to said lamp terminals, and a fuse arranged in one of the connections between terminals and contacts on said block.

INDUSTRIAL

A NEW BELL RINGING TRANSFORMER.

The electric bell and its heretofore indispensable ally, the primary battery, date back to the early days of the electrical industry. The same can be said of the alternating current transformer. But the combination of the transformer and the electric bell is of modern origin and the direct result of a desire to get rid of the troublesome and trying situations arising from the use of primary or storage batteries.

To meet this demand the General Electric Company has recently placed on the market a transformer for ringing electric bells. This transformer has a low voltage secondary winding with taps giving 6-12 and 18 volts when the primary is connected to the ordinary 110-volt lighting circuit. The transformer will operate successfully on circuits ranging from 100 to 130 volts at the usual lighting frequencies.

Materials of the highest quality are used in the construction and the design has received the same careful consideration as is given to larger transformers. Compactness, freedom from mechanical defects and absolute reliability are the resulting features.

The entire transformer is so small that it may be held in the hand. The general design has been proportioned for very low losses, the core loss being practically negligible. The transformer is designed in such a manner that a continuous short circuit on the secondary will do no damage either to the transformer or adjacent circuits.

The core and coils are placed in a small metal box with lugs or feet attached for convenience in fastening to the wall or ceiling. A screwdriver is the only tool needed for installing the transformer after which it requires no atention whatever. This is in strong contrast to the ordinary primary battery.

This transformer may also be used to advantage for operating buzzers, spark coils, burglar alarms, miniature lamps, door locks, gas lighting and annunciator systems.

GENERAL ELECTRIC EXHIBIT AT THE ALASKA-YUKON-PACIFIC EXPOSITION.

The General Electric Company's exhibit at the Alaska-Yukon-Pacific Exposition will cover a floor space of 1400 square feet in Machinery Hall and will consist mainly of various supplies, together with some larger apparatus of particular interest to that section of the country—such as mine locomotives, mine hoist equipment, electric air drills, etc.

The small material exhibit will include a display of domestic applications of small motors, arc and incandescent lighting apparatus and supplies, heating devices, oil switches, circuit breakers, rectifiers and other devices of general interest.

The booth will be given a charming Dutch treatment throughout and will, in addition to open floor space for the heavier material, consist of two rooms, one of which will be used for the complete display and demonstration purposes of cooking and heating devices, and the other for a reception room.

TRADE NOTES.

The New York office of the Weston Electrical Instrument Company, Newark, N. J., will be moved from 74 Cortlandt street to 114 Liberty street, on May 1, 1909.

The San Francisco office of the Gould Storage Battery Company, now located at 705 Monadnock Building, will on May 1st be moved to the Atlas Building, 604 Mission street.

Dossert & Company of New York City, manufacturers of Dossert Solderless Connectors, announce an arrangement just completed with Otis & Squires of San Francisco under which that company will in future take care of their interests upon the Pacific Coast.

The National Battery Company of Buffalo, New York, manufacturers of storage battery equipment, announce that they have just completed an arrangement with Otis & Squires of San Francisco, under which that firm will in future look after their interests upon the Pacific Coast.

TRADE CATALOGUES.

Condulets of all kinds, shapes and sizes are illustrated and described in a large 80-page catalogue from the Crouse-Hinds Company, of Syracuse, N. Y.

Engine type direct current generators, designed for general lighting and power service are described in bulletin No. 1059 issued by Allis-Chalmers Company of Milwaukee, Wis.

John C. Dolph Company, 153 West avenue, Long Island City, New York, sends a pamphlet explaining the advantages of their "Wayahead" non-combustible insulating compound.

Catalogues 15A and 15B from The Dale Company of New York City, John R. Cole Company, San Francisco representatives, show the tungsten fixtures and wireless clusters which they are manufacturing.

The Gould Battery in Isolated Lighting Plants is the subject of an interesting bulletin from the Gould Storage Battery Company, of 341 Fifth avenue, New York City, and Atlas building, San Francisco. It contains some valuable suggestions for economy.

Pamphlet No. 3768 from the General Electric Company, contains a comprehensive list of motor starting and speed controlling devices, both automatic and non-automatic starters. Each device is illustrated and briefly described, and the pamphlet will be of value to all interested in any way with motor drive.

A handsome publication devoted to the Curtis steam turbine-generator has recently been issued by the General Electric Company under the number 4653. This bulletin is quite elaborate so far as details of construction are concerned, containing interior views and cross-sections of various parts of turbine and generator. It describes large and small turbines of vertical and horizontal types, and contains illustrations of numerous representative Curtis turbine installations.

NEWS NOTES

FINANCIAL.

MONROVIA, CAL.—A bond election will be held in this city on June 7th to vote on the issuance of bonds for municipal improvements.

SAN FRANCISCO, CAL.—The Olympic Salt Water Company has levied an assessment of $1 per share on the capital stock of the company.

SAN FRANCISCO, CAL.—President W. B. Morris of the Western Iron Works has advertised the sale of $10,000 face value of 6 per cent bonds of the Olympia Gas & Power Company.

LOS ANGELES, CAL.—G. Watson French has filed two suits against the Paso Robles Light & Power Company, which involve 75 per cent of the capital stock of the company, valued at $45,000.

PALO ALTO, CAL.—A bond election will be held in this city on May 10th, to decide on the issuance of $16,000 in bonds for a waterworks building, $7,000 for a new water tank, $5,000 for a steel roof for the waterworks, $3,500 for a street lighting system, and $25,500 on other improvements.

INCORPORATIOINS.

BAKERSFIELD, CAL.—The Robertson Oil Company has been incorporated here with a capital stock of $75,000.

RENO, NEV.—The Lander County Power & Light Company has been incorporated here with a capital stock of $200,000.

SAN LUIS OBISPO, CAL.—The Adelaide Rural Telephone Company has been incorporated here by Otto Wyss, A. Dubost, W. I. Davis, H. C. Sutton and John Joaquin.

SAN FRANCISCO, CAL.—The S. & T. Oil Company has been incorporated here with a capital stock of $800,000 by W. G. Henshaw, V. Eingineer, J. C. Kemp, F. L. Brown and A. Raymond.

BAKERSFIELD, CAL.—The Uncas Oil Company has been incorporated here with a capital stock of $500,000 by Burke Corbet, Irving Peterson, J. R. Selby, J. M. Wilson and E. V. Whitaker.

TRANSMISSION.

HOLLISTER, CAL.—Bids will be received by the Board of Supervisors till May 17th, 1909, for an electric power franchise in this city.

RHYOLITE, NEV.—The Springdale Water & Power Company has applied for a franchise to construct an electric power plant in this city.

RED BLUFF, CAL.—Smith Crowder has filed notice of appropriating 12,000 inches of water on Mill creek for electric power purposes.

SANTA BARBARA, CAL.—Bids will be received by the City Council up till May 6th, 1909, for an electric franchise to erect power distributing systems in this city.

OROVILLE, CAL.—The Sierra Electric & Power Company has been granted a franchise to erect power distributing lines on the public roads and highways of Butte County.

BUTTE, MONT.—The Great Falls Water Power & Townsite Company has applied for a right of way for a double steel tower transmission line from Butte to Great Falls.

EUREKA, CAL.—J. N. Lenteel has located four water-rights for power purposes in this vicinity. The largest location was 20,000 inches on the Mad river about 200 feet below the mouth of Bug creek.

CORNING, CAL.—The North Electric Power Company will increase the capacity of its plant from 2000 horse-power to 60,000 horse-power, owing to the increased demand for electric power in this vicinity.

CHIHUAHUA, MEX.—M. J. O'Brien and A. P. Bronn are planning to build a 500 horse-power hydro-electric plant on Morris river. The power will be used to operate mines which are located in this vicinity.

SPOKANE, WASH.—The Washington Water Power Company this fall will start the installation of four 13,000 horse-power turbines on Middle Island in the Spokane river. The work will be in charge of C. S. MacCalla.

GEORGETOWN, CAL.—G. E. Williams and Martin Costello have filed notice of the appropriation of 400 inches of the water flowing into North Otter creek. The water power is to be utilized in generating electric power for use in the mines.

EL PASO, TEX.—C. W. Webster of the Stone-Webster Company, states that plans are under way for making extensive improvements to the present power plant, which will cost $300,000. A 2250 horse-power steam turbine engine with auxiliaries, pumps and condensers will be installed.

SPOKANE, WASH.—The Northern Idaho & Montana Power Company has been organized with a capital stock of $6,500,000, and an authorized bond issue of $10,000,000, to operate electrical properties in eastern Washington, northern Idaho and western Montana. It now controls water powers capable of developing over 100,000 horsepower at minimum flow on the Big Fork River, Moyie River and Pend o'Reille River. Plants are operated at Newport, Wash.; Sand Point, Idaho; Polson, Mont., and Kalispell, Mont. The company was promoted and financed by H. M. Byllesby & Company, engineers, and Howard, Simmons & Company, bankers, of Chicago.

ILLUMINATION.

TOMBSTONE, ARIZ.—C. L. Cummings has been granted a franchise to construct an electric lighting system in this city.

UPLANDS, CAL.—Bids will be received by the Board of Trustees till May 10th, 1909, for a fifty-year gas franchise in this city.

AZUSA, CAL.—The Covina Valley Gas Company, which recently bought out the Covina Gas Company, has asked for a franchise at this place.

OGDEN, UTAH.—Manager Danville Decker of the Utah Light & Railway Company, states that the company is to begin immediate work on enlarging the gas plant.

DOWNEY, CAL.—J. R. Gordan, owner of the electric light plant at Downey and County Farm, will extend the lines to Rivera, Norwalk and Artesia at an early day.

LOS ANGELES, CAL.—The City Council has decided to purchase the appliances needed to install the electric lighting system for Fifth street, between Main and Central avenue.

LEMOORE, CAL.—A committee has been appointed by the Trustees to secure figures from President Wishon of the San Joaquin Light & Power Company for furnishing this city with street lights.

TELEPHONE AND TELEGRAPH.

BAKERSFIELD, CAL.—The Kern Mutual Telephone Company has applied for a telephone franchise in this city.

UKIAH, CAL.—Carl Purdy and those represented by him have been granted a franchise to erect poles for a private telephone line along the public highway from the race track to Figoni's ranch.

PALA ALTO, CAL.—The Pacific Telephone & Telegraph Company, which recently spent $75,000 in improving its telephone plant here, has issued orders for further improvements to be made at an expense of several thousand dollars. The overhead wires on University avenue are to be placed in an underground conduit as far out as Waverly street.

TRANSPORTATION.

BLAINE, WASH.—Work is to be started this spring on the Nooksack Valley Traction line between Bellingham and Blaine.

ILWACO, ORE.—The Ilwaco Electric railway has a franchise to operate over the county roads between Ilwaco and Stackpole.

COEUR d'ALENE, IDAHO.—The Spokane & Inland Electric railway contemplates an extension from Coeur d'Alene to Wallace, Idaho.

LEWISTON, IDAHO.—M. A. Means of the Lewiston Terminal Company has been granted a franchise for a street car line in Lewiston.

RENTON, WASH.—E. L. Blaine has applied for permission to construct a double track electric railway along the county road between Renton and Issaquah.

SACRAMENTO, CAL.—The California Traction Company has been granted a franchise to construct electric lines on certain desired rights of way in this city.

SAN RAFAEL, CAL.—E. B. Martinelli has asked for a franchise to construct an electric road from Manzanita station up the canyon a distance of three miles.

SEATTLE, WASH.—The Seattle, Snoqualmie & Everett railway has applied for a street railway franchise along certain streets in the Exposition Heights addition to the City of Seattle.

BERKELEY, CAL.—Work began last week on the electrification of the Southern Pacific Company's interurban lines in this city, the construction of which it is stated will involve some $3,000,000. Assistant Engineer Edward G. Miller is in charge of the work.

OAKLAND, CAL.—Promoters of the Oakland & Antioch Electric Railway have succeeded, it is stated, in financing the project. Surveys for the road have been made. The projected route is across Contra Costa county. Among those promoting the company are J. Napthaly, A. W. Maltby and Allan Pollok.

PORTLAND, ORE.—The Oregon Light and Power Company has been organized by H. H. Riddell, A. E. Murphy and N. L. Bailey, all of Portland, with a capital of $2,000,000, to furnish electric light and power to Portland and the surrounding district. The plant may be ready for operation within eighteen months.

FRESNO, CAL.—Surveys have been made and capital is being secured for the construction of the proposed Fresno, Hanford & Summit Lake Interurban Railway. Construction contracts will be let as soon as bonds are placed. The projected length of this line is 40 miles, and it is to extend from Fresno to Hanford via Fowler, Selma, Kingsburg and Laton. F. S. Granger, Fresno, Cal., is general manager. Chadwick & Sykes, Crocker Building, San Francisco, Cal., are the engineers.

NAPA, CAL.—The Vallejo, Benicia & Napa Valley Railroad Company at its annual meeting held last week decided to reduce the number of directors from seven to three. The following directors were chosen for the ensuing year: President, W. T. Botsfore; vice president, Dr. E. Z. Hennessey; secretary, John T. York.

MONTEREY, CAL.—Preliminary surveys have been made for the construction of an electric railway from Monterey to Del Monte Heights. Construction work is to be started very soon. The estimated cost of the line is $35,000 and it is to be built for the Del Monte Townsite Company, room 702 Pacific Building, San Francisco, Cal.

SPOKANE, WASH.—Official announcement is made by Colonel Albert M. Dewey of Spokane, president of the Okanogan Electric Railway Company that French capitalists have taken over a bond issue of $3,000,000, the money from which will be used to build a line from Nighthawk, in north central Washington, to a point near the head of navigation on the Columbia river, 75 miles affording communication with the outside for a rich lumber, mineral and agricultural district not now served by a railroad. The road will also be extended east to Spokane and west to Seattle, making a system of more than 500 miles, for the construction and equipping of which Colonel Dewey says ample capital has been secured, adding: "We have had engineers in the field several months, running preliminary surveys for an electric railway from Spokane to Seattle and are now looking for a feasible pass through the Cascade mountains near the west fork of the upper Methow river. I have interested capitalists in the line, and if we can find the right pass we shall build by way of Bridgeport and the Methow Valley and down the Skagit river to a point which will give us a connection with the Great Northern railway at Rockport, going thence into the Sound cities. We have a 50-year franchise, right of way and charter. The line will pass through Loomis, Okanogan, Ophil, Malott, Brewster and Riverside. It will connect at the north end with Victoria, Vancouver & Eastern extension of the Great Northern railway, thus giving us Spokane connection on the east and the Sound cities on the west. We want direct communication with Seattle and Spokane and we are now running a line of survey to secure a feasible route with that end in view."

WATER.

ONTARIO, CAL.—C. A. Greenleaf has asked for a franchise to lay water pipe lines from this city to the Ocean View Tract.

LONG BEACH, CAL.—The Long Beach Water Company will move its water mains from American avenue to a private right of way in the near future. The undertaking is estimated to cost $25,000.

LARKSPUR, CAL.—The Wright Water Company has been leased for three years by Messrs. LeCornec & Larkins of that place. These gentlemen propose to increase the storage capacity of the plant as well as increase facilities for better service.

CHICO, CAL.—In order to overcome the loss of water by seepage in the ditch system of irrigation, an extensive underground pipe irrigation system is being installed at the National Plant Introduction Gardens here. In addition a 20,000 gallon tank will be stationed in the gardens to afford an ample supply of water.

SAN DIEGO, CAL.—The following bids were received by the Board of Public Works for furnishing this city with 500 lengths of 10-inch water pipe: The Western Metal Supply Company, 33.50 cents per pound; J. B. Clow & Sons, 35.50 cents per pound; Hazard, Gould & Co., 33.98 cents per pound; Christian, Froleck & Co., 33.80 cents per pound; United States Pipe Company, 33.40 cents per pound.

BAKERSFIELD, CAL.—F. T. Torpey has been granted a franchise to lay down water pipes from the Ruby Oil Company to Maricopa, to supply the inhabitants of that town.

SAN FRANCISCO, CAL.—At the annual meeting of the Spring Valley Water Company held this week it was decided to increase the number of directors from seven to eleven and an executive board, consisting of William B. Bourn, Captain Payson and Antone Borel, was created. The new directors are: President, W. B. Bourn; vice president, A. H. Payson; second vice president, S. P. Eastman; W. B. Bourn, A. H. Payson and Antone Borel, executive committee; directors, former members, W. B. Bourn, A. H. Payson, F. B. Anderson, Antone Borel, I. W. Hellman Jr., Homer W. King and J. M. Quay; new members, S. P. Eastman, T. B. Berry, E. L. Eyre, Osgood Hooker, E. J. McCutchen and Louis F. Monteagle.

OIL.

POINT RICHMOND, CAL.—A 500,000 barrel oil tank exploded here last week, injuring several people and causing a loss by fire of $100,000.

SAN FRANCISCO, CAL.—The Muscatine Oil Company will hold a meeting on June 14th to consider increasing the capital stock of the company.

BAKERSFIELD, CAL.—The annual statement of the Standard Oil Company shows a decrease of oil in store on March 1st of nearly 150,000 barrels, compared with the figures for the preceding year, being 10,038,852, as against 10,171,662 on March 1, 1908.

COALINGA, CAL.—At a meeting of the Coalinga Independent Oil Producers Agency the following directors were chosen: President, Stanley W. Morsehead; vice president, Thomas O'Donnel; second vice president, M. V. McQuigg; treasurer, H. H. Welch; secretary, R. V. Dallas.

SAN FRANCISCO, CAL.—Messrs. Smith & Byrnes, who were interested in the Seven Oil Company, have acquired some 8,000 acres in the Kreyenhagen District, about 15 miles south of Coalinga. They are now busy cleaning the abandoned wells on the Black Mountain and Black Hills properties and will endeavor to get their fuel from them.

The oil industry of California is enjoying a splendid prosperity at the present time; there is an increasing interest and activity; and investors are being attracted to the fields by virtue of the nice profits which are being made by California oil companies. The chief factors in the present movement are increasing disbursements by the listed oil companies; an increasing production of crude oil, with the demand greater than the supply of the fields, and a good price prevailing for the product.

SAN FRANCISCO, CAL.—Several important oil representatives have made statements to the effect that unless efforts are made to stop increasing the production of oil in this State prices will fall considerably. These men have recommended a suspension of all development, except such as may be necessary to protect lines or to comply with lease requirements. The output is now estimated at 10,000 barrels a day in excess of consumption and within the last 70 days the Associated Oil Company has placed in storage 728,000 barrels in the Kern River field. The yield daily is 151,000 barrels; the consumption is 142,000 barrels. At the present ratio of increase the production will be 20,000 barrels in excess of consumption by the end of the year.

SAN FRANCISCO, CAL.—In 1908 California produced over 5,000,000 barrels more than the record for 1907. There seems but little question that this year will show still greater gains, by reason of the large number of new companies which are entering the field, and which are bringing in new producers. It is likely that the output for 1909 will top the 50,000,000-barrel mark. The principal producer is Kern county, with the Kern River district leading. Next in order is the Sunset field; then, in turn, the Midway and the McKittrick. Over 300 new wells were drilled in 1908, and a larger number will be recorded for the present year. Of the forty odd listed oil companies, nearly thirty are now making regular disbursements. The dividends for March, paid by the listed companies alone, amounted to $450,000; bringing their grand total almost to the $20,000,000 mark. And to this, of course, must be added the dividends of the companies not listed on the exchange, as well as the profits made by private owners. Fuel is at a premium on the Pacific Coast, and oil has been in steadily increasing demand for fuel purposes in many lines of industrial undertaking. A big customer is the railroad interests, all the various systems looking to this fuel for operating purposes. Oil is cheaper than coal, aud oil becomes a necessity, by reason of the inadequacy of the supply of coal from the Pacific Coast. The Orient constitutes another big customer for California oil, and frequently has had to carry oil from sections farther away, because of the inability of this field to meet the demand. More uses, and relatively increasing demand for California oil, holds up the market; and in keeping therewith the opening of new producers in various sections is stimulating activity in oil well operation.

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The American Society of Mechanical Engineers will hold its spring meeting in Washington, D. C., May 4-7. Professional sessions will be held at which papers on the conveying of materials, gas power, engineering, steam turbines, the specific volume of saturated steam, oil well pumping and various other subjects will be discussed.

At the reception, which will be held in the New Willard hotel, an address of welcome will be made by the Hon. B. F. Macfarland, president of the Board of District Commissioners, with a response by Mr. Jesse M. Smith, president of the society.

During the convention President Taft will hold a reception for the members at the White House. The War Department will give a special exhibition drill of the U. S. troops at Fort Myer, to which the members and guests will be invited. At the same time, if the conditions are favorable, an ascension of a dirigible balloon will be made and probably also that of an aeroplane.

An address will be given by Rear-Admiral Melville, retired, past president of the society, and former engineer-in-chief of the navy, the subject being "The Engineer in the Navy." This evening will be made the occasion for the presentation to the national gallery of a portrait of Rear-Admiral Melville presented by friends and admirers. It will be received for the national gallery by Dr. C. D. Walcott, secretary of the Smithsonian Institution.

F. H. Newell, director of the Reclamation Service, will deliver an illustrated address on "Home Making in the Arid Regions." Trips will be made to various points of interest about the city and a number of pleasurable excursions have been planned.

The papers to be presented are as follows:

A Unique Belt Conveyor, Ellis C. Soper; Automatic Feeders for Handling Material in Bulk, C. Kemble Baldwin; A New Transmission Dynamometer, Prof. William H. Kenerson; Polishing Metals for Examination with the Microscope, A. Kingsbury; Marine Producer Gas Power, C. L. Straub; Operating System for a Small Producer Gas Power Plant, C. W. Obert; A Method of Improving the Efficiency of Gas Engines, T. E. Butterfield; Offsetting Cylinders in Single-Acting Engines, Prof. T. M. Phetteplace; Small Steam Turbines, George A. Orrok; Oil Well Tests, Edmund M. Ivens; Safety Valve Discussion; Specific Volume of Saturated Steam, Prof. C. H. Peabody; Some Properties of Steam, Prof. R. C. H. Heck; A New Departure in Flexible Staybolts, H. V. Wille.